CLERK'S COPY.

OFFICE COPY.

Vol. II

TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1930

No. 48

AMERICAN FRUIT GROWERS, INC., PETITIONER,

vs.

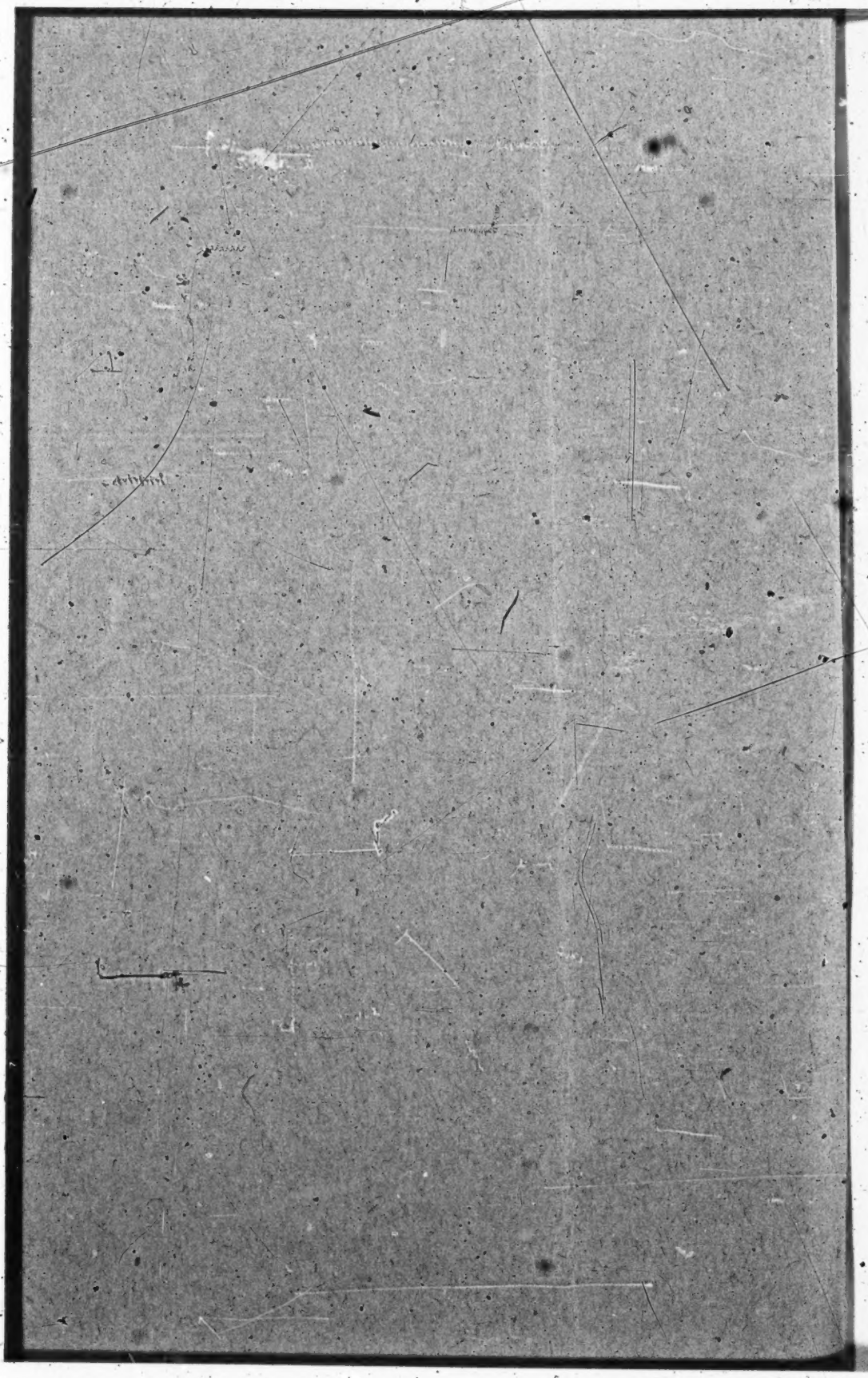
BROGDEX COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE THIRD CIRCUIT

PETITION FOR CERTIORARI FILED FEBRUARY 15, 1930

CERTIORARI GRANTED MARCH 17, 1930

(34,798)



(34,798)

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1930

No. 48

AMERICAN FRUIT GROWERS, INC., PETITIONER,

vs.

BROGDEX COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE THIRD CIRCUIT

VOL. II

INDEX

	Original	Print
Plaintiff's Exhibit 10 (continued)—Circular No. 19, U. S. Department of Agriculture, "The Decay of Florida Oranges While in Transit and on the Market," by L. S. Tenny	185	769
11—American Review of Reviews, 1909, "Improved Methods of Fruit-Handling," by F. J. Dyer	191	777
12—Circular No. 26, U. S. Department of Agriculture, "Some Factors Affecting the Keeping Qualities of American Lemons," by R. H. True	199	788
13—Proceedings of twenty-second annual meeting of Florida State Horticul-		

JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., JUNE 27, 1930

	Original	Print
tural Society, May, 1909, "Packing and Shipping Citrus Fruits," by L. S. Tenny	219	808
Plaintiff's Exhibit 14—Proceedings of twenty-third annual meeting of Florida State Horticultural Society, May, 1910, "Causes of Decay of Florida Oranges in Transit to Market," by A. V. Stubenrauch	251	835
15—Proceedings of twenty-fourth annual meeting of Florida State Horticultural Society, May, 1911, "Stem-end Rot and Gummosis," by H. S. Fawcett	283	864
16—Circular, Citrus Protective League, February 4, 1911, "The Decay in Citrus Fruits While in Transit," by G. Harold Powell	301	880
17—Circular No. 2, Citrus Protective League, February 18, 1911, "The Prevention of Decay in Citrus Fruits," by G. Harold Powell	305	883
18—Bulletin U. S. Department of Agriculture, July 13, 1911, "The Relation of Handling to Decay in California Navel Oranges; Season of 1910-11," by A. V. Stubenrauch	310	888
19—Bulletin No. 108, University of Florida, November, 1911, "Diseases of Citrus Fruits," by Rolfs, Fawcett and Floyd	321	897
20—Proceedings of twenty-fifth annual meeting of Florida State Horticultural Society, May, 1912, "The Relation of Handling to Decay of Florida Oranges in Transit and on the Market," by H. J. Ramsey	325	902
21—"The Handling and Precooling of Fruits for Transportation," by A. V. Stubenrauch, 1912	348	922
22—Letter, Fruit, November, 1912, pages 59-65, "Fruit Handling and Precooling Investigations," by A. V Stubenrauch	353	926
23—Proceedings of twenty-sixth annual meeting of Florida State Horticultural Society, May, 1913, "Citrus Fruit Handling and Storage," by A. W. McKay	363	936
24—Bulletin No. 63, U. S. Department of Agriculture, March 28, 1914, "Factors Governing the Successful Ship-		

	Original	Print
ment of Oranges from Florida," by A. V. Stubenrauch	399	967
Plaintiff's Exhibit 25—Bulletin No. 7, Board of Commissioners of Agriculture, Porto Rico, "The Handling of Porto Rican Oranges, Grapefruit, and Pineapples," by C. W. Mann	465	1051
26—Proceedings of twenty-seventh annual meeting of Florida State Horticultural Society, April-May, 1914, "Packing and Shipping Citrus Fruits," by S. F. Poole	468	1054
27—Agricultural Gazette of New South Wales, Vol. XXV, November 2, 1914, "Fungus and Other Diseases of Citrus Trees"	492	1075
28—The Florida Grower, Vol. X, No. 8, May 23, 1914, pp. 10-11	497	1079
29—Porto Rico Progress, Vol. VIII, No. 1, December 23, 1914, pp. 5-7, "The Rot of Citrus Fruit"	501	1080
30—Proceedings of the twenty-eighth annual meeting of Florida State Horticultural Society, April, 1915	506	1084
31—Circular, U. S. Department of Agriculture, 1915, "The Relation of Washing to Decay in Washington Navel Oranges," season 1914-15"	517	1093
32—Bulletin No. 696, U. S. Department of Agriculture, November 10, 1915, "Handling and Shipping Citrus Fruits in the Gulf States," by H. J. Ramsey	525	1097
33—"Citrus Fruits," 1915, by J. Eliot Coit	553	1132
34—Proceedings of forty-eighth California State Fruit Growers' Convention, "The Causes of Unnecessary Decay in Lemons," by R. L. Willits	557	1136
35—Standard Cyclopedia of Horticulture, by L. H. Bailey, pp. 3367-71	567	1145
36—Quarterly Bulletin of the State Plant Board of Florida, October, 1917	585	1161
37—Quarterly Bulletin of the State Plant Board of Florida, July, 1918	588	1164
38—The California Citrograph, July, 1920	610	1184
39—Monthly Bulletin of Department of Agriculture, California, September, 1920, "Decay in Citrus Fruits During Transportation," by O. F. Burger	613	1186

	Original	Print
Plaintiff's Exhibit 40—The California Citrograph, March, 1921, "Need of Care to Prevent Blue Mold Decay in Transit," by H. J. Ramsey	622	1195
41—Circular No. 293, U. S. Department of Agriculture, October, 1923, "Commercial Control of Citrus Stem-end Rot"	629	1200
42—Leaflet No. 114, Western Australia Department of Agriculture, 1923, "The Occurrence of Blue Mold on Citrus Fruits," by W. M. Carne	639	1215
43—"American Fruits," 1924, by Samuel Fraser, pp. 190, 191, 275, 632, 633	643*a*	1219
44—Leaflet, U. S. Journal of Agricultural Research, May 31, 1924, "Preliminary Results With the Borax Treatment of Citrus Fruits for the Prevention of Blue Mold Rot"	649	1223
45—The Florida Grower, November 1, 1924, "Controlling Blue Mold Rot of Citrus Fruits with Borax Solution," by Fulton and Winston	657	1230
46—Bulletins of Florida Citrus Exchange to subexchanges and association managers	659	1241
47—The Citrus Industry, February, 1925, "Preliminary Report of the Effect of Hot Water, Hot and Cold Borax Solution on Scale Insects," by W. W. Yothers	670	1250
48—The California Citrograph, March, 1925, "Treating Oranges with Borax Solution for Control of Blue and Green Mold," by W. R. Barger	671*a*	1251
49—Proceedings of thirty-eighth annual meeting of Florida State Horticultural Society, April, 1925, "The Borax Treatment of Citrus Fruit for Prevention of Decay," by H. R. Fulton	673	1256
50—Journal of Agricultural Research, Vol. XXX, No. 2, January 15, 1925, "Borax as a Disinfectant for Citrus Fruits," by Barger and Hawkins	685	1265
51—The Florida Grower, October 10, 1925, "Borax as a Preventive of Decay," by J. W. Andrews	691	1275

	Original	Print
Plaintiff's Exhibit 52—"The Cultivation of Citrus Fruits," 1926, by H. Harold Hume, pp. 483-484	699	1281
53—Fulton & Bowman U. S. patent No. 1,557,757, October 20, 1925	703	1284
54—Fulton & Bowman U. S. patent No. 1,557,758, October 20, 1925	705	1288
55—Barger, Hukill & Hawkins U. S. patent No. 1,559,733, November 3, 1925	707	1292
56—Fulton & Bowman U. S. patent No. 1,560,558, November 10, 1925	711	1295
57—Fulton & Bowman U. S. patent No. 1,560,559, November 10, 1925	713	1299
58—Fulton & Bowman U. S. patent No. 1,571,938, February 9, 1926	715	1302
59—Barger & Hawkins U. S. patent No. 1,598,697, September 7, 1926	717	1305
60—Letter, E. G. Dezell, December 19, 1924, "to all shippers," California Fruit Growers' Exchange	719	1307
61—Letter, E. G. Dezell June 20, 1924, "to all shippers," California Fruit Growers' Exchange, with report of tests annexed	724	1312
62—Bulletins of California Fruit Growers' Exhange "to all shippers"	742	1329
63—Circular No. 524, Fruit Growers' Supply Co	753	1338
64—Chart showing specific gravity of borax solutions	755	1339
65—Circular, Chase & Co., summary decay analysis	757	1340
66—Letter, H. R. Fulton to J. B. Skinner, November 17, 1924	759	1341
67—License agreement, dated September 9, 1924, between Brogdex Co. of Florida and Mutual Orange Distributors	760	1342
68—License agreement, dated June 18, 1926, between Brogdex Co. and Skinner Machinery Sales Co	772	1352
69—Brogdex drawing of Haines City, Florida, plant of defendant	785	1362
70—Brogdex drawing of Volusia Growers, Inc., plant, De Land, Florida	786	1362
71—Brogdex drawing of New Smyrna, Mims, and Cocoa, Florida, plants	787	1362
72—License agreement, June 24, 1926, between Skinner Machinery Sales Co. and Brockett & Parrish	789	1363

		Original	Print
Plaintiff's Exhibit	73—Lease from Skinner, Machinery Sales Co. to Brockett & Parrish	799	1372
	74—Bulletin, No. 495, U. S. Bureau of Standards, "A Radiometric Investigation of the Germicidal Action of Ultra-Violet Radiation," by Coblentz and Fulton	805	1377
	75—Bulletins of Florida Citrus Exchange with license and lease agreement with Zeltrocide Chemical Corporation	853	1419
	76—Delivery slip of Downing's Grocery & Meat Market to Rialto Heights Association, California	877	1435
	77—Bill, Blue Goose Pharmacy to Rialto Heights Association	878	1435
	78—Delivery slip of Downing's Grocery and Meat Market to Rialto Heights Association, California	879	1435
	79—Bills (three) of Needham Brothers to Rialto Heights Association	880	1435
	80—Shipping order Pacific Coast Borax Co. to Rialto Heights Association	883	1435
	81—Horrell and Bryant U. S. patent No. 944,933, December 28, 1909	883*a*	1435
	82—Telegram, April 28, 1926, B. C. Skinner to The Brogdex Co	889	1441
	82-A—Confirmation of telegram, Exhibit No. 82	890	1442
	83—"Problems in Shipping Citrus Fruits," by A. Sandlin	890	1442
	84—Check of E. V. Bauchelie to Rialto Heights Association	897	1447
	84-A—Bill of Rialto Heights Association to J. F. Bauchelle	898	1447
	85—"Insecticides, Fungicides, and Weed-killers," 1913, by E. Bourcart, pp. 97 and 208	899	1447
	86—"The Physiological Effect of Various Agents on the Development of Some Molds," by Bitting, p. 5 (addition to Defendant's Exhibit No. 17)	902	1450
Defendant's Exhibit	1—Defendant's decay sheets, season, 1924-25	904	1453
	2—Defendant's decay sheets, season 1925-26	905	1456
	3—Circulars of defendant to packing house managers	907	1458
	4—Circulars of defendant to packing house managers, re use of borax	912	1462

	Original	Print
Defendant's Exhibit 5—Letter, October 17, 1921, E. M. Brogden to A. B. Michael, with memorandum, "A Few 'Brogdex' Experiments, etc.," annexed....	915	1464
6—Articles of incorporation of Antiseptic Fruit and Egg Packing Co.	922	1470
7—Bishop U. S. patent No. 638,899, October 8, 1901.....	927	1473
8—Chart, tests of Blue Mold decay..	929	1474
9—Report of Dr. H. C. Gore on experiments with boric acid.....	931	1475
10—Circular No. 27, August, 1922, U. S. Department of Agriculture, "Some Experiments with a Boric-acid Canning Powder".....	939	1480
11—Bulletin No. 109, U. S. Department of Agriculture, "The Molds of Cigars and Their Prevention"....	953	1495
12—Annual report, Commissioner of Agriculture, 1878, "Borax as a Preservative of Butter," p. 577..	965	1504
13—Journal d'Agriculture Practique, 1883, January 19, Vol. 46/I, pp. 75-76, translation.....	967	1506
14—Proceedings of Indiana Academy of Science, 1909, "The Effect of Preservatives on the Development of Penicillium," by Katherine G. Bitting	969	1507
15—Flolia Microbriologica, 1912, "On the Effect of Boric Acid and Several Other Compounds Upon the Development of Penicillium Glaucum and Aspergillus Niger," translation	977	1516
16—"Insecticides, Fungicides and Weed-killers," by E. Bourcart, 1913....	984	1521
17—"The Effect of Certain Agents on the Development of Some Molds," by K. G. Bitting.....	987	1525
18—Chemistry of Plants, "Action of Boric Acid on Germination," by J. Morel, translation.....	996	1535
19—Spear U. S. patent No. 67,921, August 20, 1867.....	1001	1538
20—Donn U. S. patent No. 161,944, April 13, 1875.....	1005	1546
21—Am Ende U. S. patent No. 187,956, March 6, 1877.....	1006	1547
22—Jourdes U. S. patent No. 199,209, January 15, 1878.....	1007	1548

	Original	Print
Defendant's Exhibit 23—Janmasch U. S. patent No. 216,414, June 10, 1879	1008	1550
24—Fagersten U. S. patent No. 221,541, November 11, 1879	1009	1552
25—Hauff U. S. patent No. 234,567, November 16, 1880	1010	1554
26—Grier U. S. patent No. 268,094, November 28, 1882	1011	1555
27—Humiston U. S. patent No. 270,899, January 23, 1883	1012	1558
28—Pielsticker U. S. patent No. 281,554, July 17, 1883	1013	1559
29—Morris and Parker U. S. patent No. 556,471, March 17, 1896	1015	1563
30—De Sturler U. S. patent No. 694,301, February 25, 1902	1017	1566
31—Peters U. S. patent No. 1,245,380, November 6, 1917	1018	1568
32—McDill U. S. patent No. 1,400,086, December 13, 1921	1023	1574
33—Olsson British patent No. 1893 of 1869	1025	1578
34—Wilkins British patent No. 2438 of 1880	1032	1584
35—Nawrocki British patent No. 4910 of 1880	1033	1585
36—Wilkins British patent No. 140 of 1881	1035	1587
37—Barff British patent No. 1362 of 1881	1038	1590
38—Wetter British patent No. 3823 of 1881	1040	1593
39—Townsend British patent No. 6134 of 1882	1042	1594
40—Storer British patent No. 214 of 1888	1046	1598
41—Hausler British patent No. 9145 of 1893	1048	1601
42—Harvey British patent No. 25,512 of 1906	1050	1603
43—The Horticulturalist's Rule Book, 1898	1055	1611
44—Letter, L. D. Niles to W. E. Conner, September 20, 1900	1058	1613
45—Letter, L. D. Niles to Hon. Washington Conner, March 24, 1900	1059	1614
Clerk's certificate.....(omitted in printing)..	1060	
Order allowing certiorari	1061	1615

[fol. 185] Table I.—Percentage of Injured Fruit with Long Stems Found in the Oranges Handled by Eight Pickers

No. assigned to picker	Injuries by clipper cutting Per cent	Other injuries Per cent	Leng stems Per cent	Total injuries and long stems Per cent
1	0.8	3.4	0.4	4.6
2	8.1	21.4	12.7	42.2
3	3.9	6.1	14.4	24.4
4	6.3	6.7	25.0	38.0
5	7.2	9.6	25.3	42.1
6	2.0	5.0	8.0	15.0
7	5.0	18.0	22.5	45.5
8	15.9	6.6	25.8	48.3
Average	6.1	9.6	16.8	32.5

Picker No. 8 had also pulled 16 per cent of the fruit from the trees instead of cutting it off.

The amount of injury in picking the orange is not necessarily connected with the rapidity of the work done by the pickers. A slow picker may injure as many oranges as a rapid worker, and neither may know that he is injuring the fruit with the clippers. The following data regarding the work of a gang consisting of a picking foreman and three pickers who were paid by the box illustrate this fact:

Table II.—Percentage of Injured Fruit and Fruit with Long Stems Found in the Oranges Picked by Slow and by Rapid Workers

Kind of worker	Injuries by clipper cutting Per cent	Other injuries Per cent	Long stems Per cent	Total injuries and long stems Per cent
Slow picker	23.4	0.0	9.6	33.0
New picker	11.0	4.0	5.5	20.5
Fast picker	10.7	2.4	4.0	17.1
Do	3.2	6.3	7.4	16.9
Boxes selected from fruit in packing house	13.2	6.0	7.0	26.2

These tables show the extent of damage that may be done in handling the fruit in the groves in Florida.

Packing House Experiments

Fruit handled in the following ways was packed and held two weeks in the packing houses in Florida and was then

examined for decay: (1) Carefully picked fruit, all injured oranges being taken out and the fruit graded and sized by hand; (2) carefully picked fruit, all injured oranges being taken out and the fruit graded and sized by machinery in the usual way; (3) carefully picked fruit, all injured oranges being taken out and the fruit graded and sized by hand, but just previous to packing each orange was dropped 18 to 20 inches to the floor or the bottom of a field crate; (4) fruit picked, packed, and graded in the usual commercial way; (5) fruit consisting of oranges showing some mechanical injury.

The experiments which included these five methods of handling fruit, the different lots for each experiment being selected from the fruit of the same grove, were made in [fol. 186] nine packing houses in different localities in the orange section of the State during the season of 1907-8. In every experiment, the sound, carefully handled fruit that was graded and sized by hand showed the least decay at the end of two weeks. The decay in the fruit which was carefully picked but graded by machinery varied much. In one experiment the carefully handled fruit showed 1.1 per cent of decay, while a similar lot which was handled by machinery contained 18.4 per cent of decay. In another test where the hopper was unusually large and steep and the machinery of the oldest type the decay was 36.7 per cent. The average loss for the season of 1907-8 for all fruit which passed through the machinery but was carefully handled in picking was 20.3 per cent, in comparison with 2.1 per cent for similar lots graded and sized by hand.

The experiments in which the oranges were dropped were made in order to determine what proportion of the decay was caused by dropping the fruit into the picking basket or field crate, by dumping into the hopper, or by any fall which the fruit might have in being delivered from the sizer to the bins. A distance of 18 to 20 inches was selected for the drop, since it was possible to see large quantities of fruit dropped that distance or farther in its commercial handling. During the season of 1906-7, the decay from dropping seemed to be greater than in 1907-8. The average loss for the first season was 20.1 per cent, while for the past season it was 10 per cent.

The boxes designated "commercially packed oranges" were selected from the packed boxes in the house as the cars were being loaded, care being taken to select fruit from the groves from which the other experimental boxes had been secured. The average decay in 1906-7 for the commercially packed fruit was 22.9 per cent; in 1907-8 the loss was 18.2 per cent.

Each of the mechanically injured oranges was selected because it showed some kind of a puncture or abrasion of the skin. The mechanically injured fruit after being packed for two weeks developed 48.7 per cent of decay in 1906-7; in 1907-8 the loss was 35.4 per cent.

The following table summarizes the percentage of decay found for the last two seasons in the fruit held for two weeks in the packing houses:

Table III.—Average Percentage of Decay in Oranges Handled in Various Ways and Held in Packing-houses for Two Weeks.

1906-7

	Per cent
Sound oranges graded by machinery	20.3
Oranges dropped from 18 to 20 inches	20.1
Commercially packed oranges	22.9
Mechanically injured oranges	48.7

1907-8

	Per cent
Sound oranges graded by hand	2.1
Sound oranges graded by machinery	29.3
Oranges dropped from 18 to 20 inches	10.0
Commercially packed oranges	18.2
Mechanically injured oranges	35.4

[fol. 187] Shipping Experiments and Market Tests

During the season of 1907-8 fourteen shipments of oranges handled in a way similar to the oranges in the packing-house experiments were shipped to Washington and there held under market conditions, the amount of decay being determined on arrival and at the end of each succeeding week. As the weather was cool during the shipping season nearly all of the lots except the injured

fruit reached Washington in fair condition. The sound fruit graded by hand showed the least decay. At the end of the first week in storage, the sound, carefully handled fruit remained in excellent condition, while all other lots began to show considerable decay. The commercially packed oranges, which contained less than 4 per cent of decay on arrival in Washington, developed more than 10 per cent at the end of one week. At the end of the second week, the carefully handled fruit was still in prime condition, with 4.5 per cent of loss, while all the other lots were badly decayed.

The following table gives a summary of the shipping experiments of 1907-8, the amount of decay when the fruit arrived in Washington and at the end of the first and the second weeks in storage being specified:

Table IV.—Percentage of decay on arrival in Washington and after one week and two weeks in oranges handled in different ways.

Character of oranges shipped	Decay on arrival	Decay after one week	Decay after two weeks
	Per cent	Per cent	Per cent
Sound oranges graded by hand.....	0.4	1.9	4.5
Sound oranges graded by machinery...	1.1	5.4	12.4
Oranges dropped from 18 to 20 inches	2.3	6.0	10.9
Commercially packed oranges.....	3.9	10.6	18.1
Mechanically injured oranges.....	20.2	38.0	52.4

Table IV shows that the Florida orange has good keeping quality when the handling has been sufficiently careful. On the other hand, it is apparent that careless handling prepares the way for decay, either while the fruit is in transit or after it has reached the market.

The present methods of harvesting citrus fruits in many cases in Florida are extremely rough, and a premium is placed on the quantity rather than on the quality of work done. This is due to the class of labor employed, to a desire on the part of the packer to reduce the cost to the lowest possible figure, and to a lack of knowledge of the value of careful handling.

Table V shows that it is possible, even with the present labor, to lessen materially the amount of injury done in picking the fruit. The oranges showing clipper cuttings or other injuries or bearing long stems were counted on December 4 and 6, before any educational work had been

done among the pickers. In two weeks another examina- [fol. 188] tion of the fruit was made, and after ten days still another. Meantime, each picker was shown how much damage was being done and was told what effect this injury had upon the keeping quality of the fruit.

Within the three weeks specified the amount of clipper cutting was reduced to one-seventh and the total injury and number of long stems to less than one-fourth of the former amounts.

FIG. 1.—An interior view of a packing house in Florida, showing the large hoppers used for delivering oranges to the sizing machine.

Table V.—Percentage of oranges showing mechanical injuries and long stems picked by the same gang before and after instruction as to care in handling.

Date of inspection	Injury by clipper cutting	Total injuries and long stems	Date of inspection	Injury by clipper cutting	Total injuries and long stems
	Per cent	Per cent		Per cent	Per cent
December 4[a]	7.4	18	December 17[b]	2.3	6
December 6[a]	5.6	22	December 27[b]	1.0	4

[a] Before instruction

[b] After instruction

There is much opportunity for improvement in the handling of the fruit in the packing houses also. The use of any kind of hopper is a source of much injury on account of the dumping of the fruit from the field crate. The large hopper used extensively in Florida tends to increase this injury. (See fig. 1.) It is probable that the hopper can be eliminated entirely and the fruit delivered to the sizing machine on carrying belts. Many such arrangements have been in operation in California for the last two seasons [fol. 189] and are giving excellent satisfaction. (See fig. 2.)

Many of the conditions in California in 1905, when the investigation was undertaken there by the Bureau of Plant Industry, were much like those in Florida. During the course of the investigation, many changes favoring more careful handling of the fruit, both in the groves and in the packing houses, have been made. The following descrip-

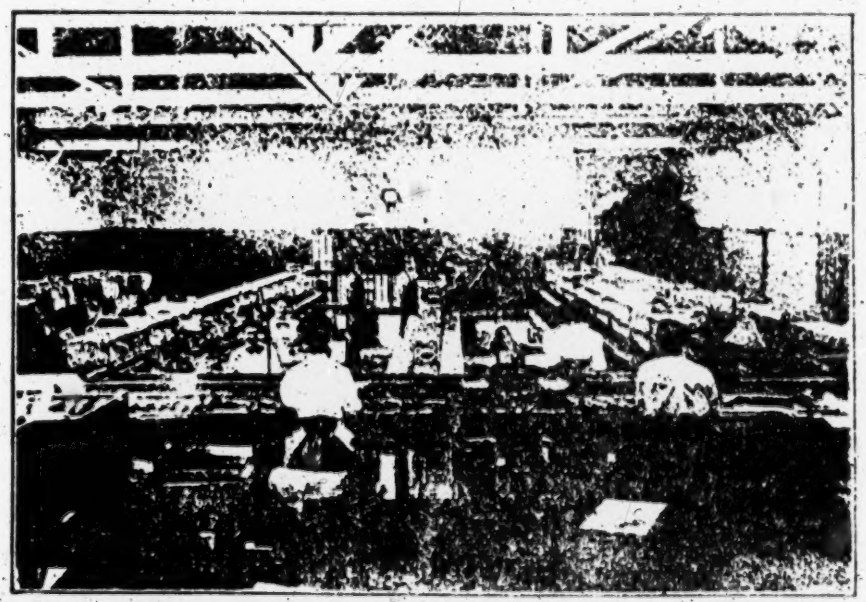


FIG. 2.—Interior view of a packing house in California, showing the machinery used in preparing oranges for shipment.

tion given in the bulletin already referred to[a] shows what successful results have followed:

Methods used in preventing decay in oranges in a large commercial business.—The fruit shipped under the last series[b] was grown and packed by a corporation owning

Date of first shipment	Decay following immediate shipment and approximate delay of 2 days and 4 days			
	No delay	2 days	4 days	Average decay
	Per cent	Per cent	Per cent	Per cent
February 26	0.7	0.8	1.3	0.9
March 19	1.8	1.7	1.8	1.8
April 1	1.0	1.9	2.3	1.7
April 19	0.8	1.4	2.7	1.6
May 1	2.7	1.7	2.7	2.4
Average	1.4	1.5	1.9	....

[fol. 190] several hundred acres of groves and packing its own fruit. When the present investigation of the Bureau of Plant Industry was undertaken in 1905, the fruit from this house sometimes arrived in market showing from 5 to 30 per cent of decay. The handling of the fruit was done with the average care used in preparing the fruit for market at that time. An investigation showed that 20 to 25 per cent of the oranges were cut with the clippers or were stem punctured, and that the packing house, which was equipped with overhead sizers, contributed to the further injury of the fruit. In 1906 and in 1907 the fruit was picked with care. The labor in the groves is paid by the day. It is under the management of a competent foreman. As a rule the orange as cut from the tree has a long stem, and a second cut removes the stem close to the fruit. The pickers average from 40 to 50 boxes a day, and the clipper cutting and stem puncturing have been reduced to from 1 to 3 per cent. The loading and the hauling of the boxes to the packing house are done with care. Gravel is kept out of the boxes and they are not filled full enough to bruise the oranges on the top when the boxes are stacked. The packing house is handled by a skillful foreman. The

[a] Bulletin No. 123 of the Bureau of Plant Industry, entitled "The Decay of Oranges while in Transit from California." 1908.

[b] Percentage of decay in oranges handled carefully under commercial conditions and shipped under ventilation from February to May, 1907.

oranges are not brushed. The machinery is of the simplest kind and is run at comparatively low speed. The packing and the loading of the cars are done with care. The packers average from 50 to 60 boxes a day. The fruit has been shipped under ventilation until about two months after most of the shipment from southern California have begun to be forwarded under ice.

From the business standpoint this fruit took high rank in the market as soon as careful handling methods were adopted in 1906 and it has held it ever since. In addition to a good pack, it has commanded the confidence of buyers on account of arriving in sound condition day after day. The excess in net return has been many times greater than the extra cost of careful handling. The extra cost of handling the fruit carefully has probably not amounted to 10 cents a box.

What has been accomplished here can be duplicated, so far as the sound arrival of the fruit is concerned, by any other shipper in California who will preserve the natural keeping quality of the fruit by handling it carefully in the grove and packing house rather than attempting to handle the shipments at the lowest possible cost under conditions that make the fruit susceptible to decay.

Conclusion.

The experimental work indicates that what has been accomplished in California may be duplicated in Florida. The decay of oranges is closely connected with rough methods of handling the fruit. Careful methods result in good keeping quality. Rough and careless work should be expected to cause decay, and the experiments show that this is true.

Approved:

JAMES WILSON,
Secretary of Agriculture.

Washington, D. C. October 22, 1908.

[fol. 191] PLAINTIFF'S EXHIBIT No. 11

U. S. Department p. 19

The American Review of Reviews

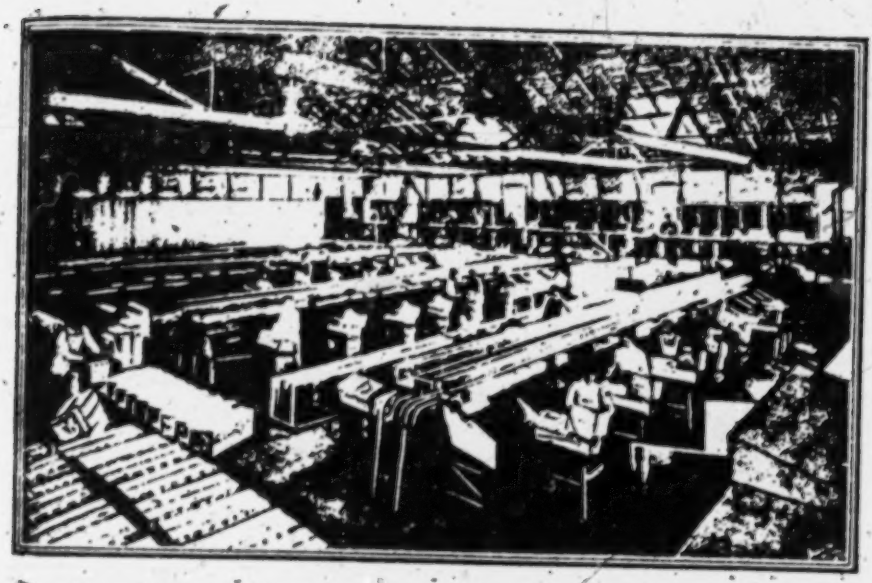
An International Magazine

Edited by Albert Shaw

Volume XXXIX January-June, 1909

The Review of Reviews Company
New York, 13 Astor Place

[fol. 192]



Boxing California Oranges for Shipment in an Up-to-date Packing-house

Improved Methods of Fruit-Handling

By Francis John Dyer

Consider what it would mean to the world if there should be such a revolution in methods of handling and shipping that the finest table grapes, peaches, apricots, strawberries,

and other delicate but delicious horticultural products could be transported from their native vineyards, orchards, and berry-patches to the remotest markets in perfect condition. A Georgia peach is a luscious but a delicate thing. Yet an expert of the Department of Agriculture says that it is easier to get a ripe Georgia peach from New York to London with proper handling than it is to get it from Georgia to New York under ordinary shipping conditions.

It may seem at first but a little thing to the uninitiated; in reality, it is one of the greatest problems of the new century. Setting aside the benefit to the consumer,—for we can all appreciate the advantage of having plenty of ripe fruit just as good and probably just as cheap as if raised in the country adjacent to one's place of residence,—consider what it would mean to the world's commerce. Fruit culture at this day is universal, so that every section of the country would benefit. But some sections are better suited to fruit-growing than others, and certain fruits grow well or attain their best perfection only in certain localities. Pre-eminent in fruit growing is California; but Washington, Oregon, Colorado, Arizona, Michigan, New Jersey, New York, Delaware, Florida, Texas, Louisiana, and all the rest of the States and Territories also produce fruit. The apples of the Shenandoah Valley divide the favor of the public with those from Oregon's Rogue River Valley, and the peaches of Georgia and Delaware and Michigan and Colorado fight for supremacy in the markets with those from California. In certain lines the latter State is easily first, yet, with all of its advantages of soil and climate, it has always been a problem how to get California's fruit crop to market in a condition fit for consumption. The perishable quality of ripe, or even of partially ripe, fruit has always been apparent, and so it came that the growers and shippers felt themselves compelled to rely on sending to market unripe fruit in refrigerator cars attached to fast freight or express trains, resulting in placing before the consumer an unsatisfactory article at such a heavy cost for [fol. 193] handling, icing, and transportation that the grower was held fortunate if he had anything at all left for himself after paying the bills charged up against him. Added to this was a constant loss from decay in transit, which was often a heavier tax than any other on the receipts.

While the value of the fresh fruit crop has grown until it is represented by hundreds of millions of dollars, the marketing of it has gone on for many years with no improvement of importance except quicker transportation and the adoption of refrigerating and cooling devices. There came a limit to development on these lines, and then the progressive horticulturists of California and Florida, carefully inquiring into the reasons why they failed to make the profit that seemed possible with oranges, peaches, and other fruits so cheap at the orchard that they were hardly worth the cost of picking, and selling at 5 cents and more for individual fruits in New York, decided that one prime reason for failure to get their share of the profit lay in the decay of the fruit in transit. This was long after distrust of the middleman led to the organization of the California fruit-growers' exchanges for the marketing of their own fruit. The exchanges helped but they did not cure all the troubles of the growers; so the Hon. James Wilson, Secretary of Agriculture, was called on, and in response to the appeal of the citrus fruit-growers he sent out experts to investigate the matter. That was the beginning. The details, worked out painfully, scientifically, accurately, untiringly, by trained men from the Department of Agriculture, can be had by any one who cares to ask for the reports made by them to their chief. The results are what the public and the growers care for; and the results are of the very highest importance.

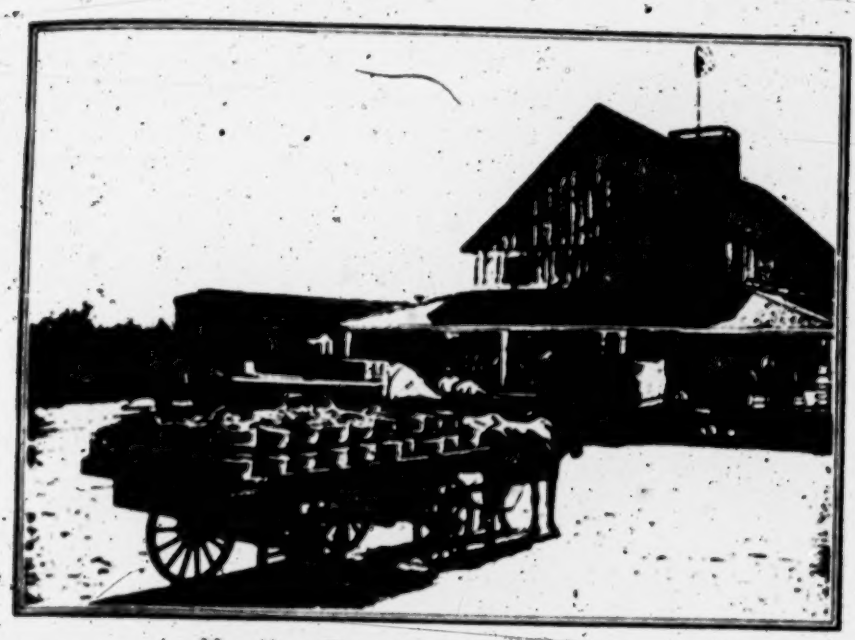
Like many other scientific discoveries, that relating to the proper methods of handling and marketing fresh fruit seems very simple when it is known, yet it took careful study before the facts were disclosed. The secret, briefly, consists in careful handling to avoid injuring the fruit before shipment, proper and uniform cooling before shipment, and co-ordination by the various agencies having the fruit in charge from the time it leaves the orchard until it gets to the consumer. Under the time-honored system still chiefly in practice the orchardist felt that he had done his part when he delivered his fruit to the transportation company; the latter took the fruit and conveyed it in refrigerated cars to its destination, feeling that its task was properly fulfilled. The selling agent or produce-man disposed of it to the best advantage, deducting losses from decay, and felt that his work was complete. The producer

received his report of losses from rot more or less incredulously, and felt that there was bad management or dishonesty of which he was the victim. No one was conscious of wrong methods. It was a puzzling problem, but the Department of Agriculture set out to solve it.

Some of the first work done to ascertain causes of decay in fruit was at the Geneva Experiment Station in New York, in charge of Prof. N. P. Hedrick. The object was to ascertain whether apples grown in highly cultivated orchards had better keeping qualities than those from orchards which were sodded. These experiments were carried on for three or four years, and satisfied the department that while apples from grass-grown orchards were more highly colored, those from cultivated orchards kept better.

Handling New York Pears for Export

Next there was started an investigation of conditions governing the export of Bartlett pears from western New York, in 1902. The problem to be met was how to prevent a glut due to an immense production of Bartlett pears for several successive years from Michigan eastward to the Atlantic Coast, and especially in western New York. Commercial exports of pears were failures because the fruit, packed in barrels, arrived in London overripe and the effort to ship abroad was practically abandoned, although California pears, shipped in boxes and half-boxes, arrived in London in fair condition. The Government experts took up the question, and shipped a fifty-barrel lot of pears from Niagara County, New York, to London. The fruit reached its destination in fair condition and netted a good profit. The next year pears were shipped in carload lots, some in barrels and some in boxes and half-boxes. The fruit in boxes fetched the highest price of any carload shipped that year from Niagara County, so that the commercial shippers were encouraged to step in, and they developed a large export business in Bartlett pears. The experts under Mr. Powell continued their experimental work in storage, and discovered that the failure of the fruit to carry well in barrels was due to the fact that there was too large a mass of fruit to cool quickly and uniformly. After storage the fruit around the outside of the barrel was found to be [fol. 194] sound, while that in the center was overripe. As



Hauling Peaches for Shipment

(A packing house in the Georgia fruit district)

the fruit softened it became more compact, allowing the sound fruit to shake about with resulting bruises, from which rot developed.

As a result of these experiments there has been a wider sale for Bartletts with no glut of fruit in the American markets. Of course, it is recognized that pressure from California has decreased because of the pear blight, but, on the other hand, whenever the market is high enough to warrant it, pears are shipped to London with good success. The withdrawal of New York pears from the markets of the Middle West has been a great benefit to Michigan, which State now supplies the bulk of the Bartletts consumed in Chicago, Milwaukee, St. Paul, Minneapolis, and all the upper part of the Mississippi Valley, and the market for winter apples has been similarly benefited.

Cooling Georgia Peaches in Transit

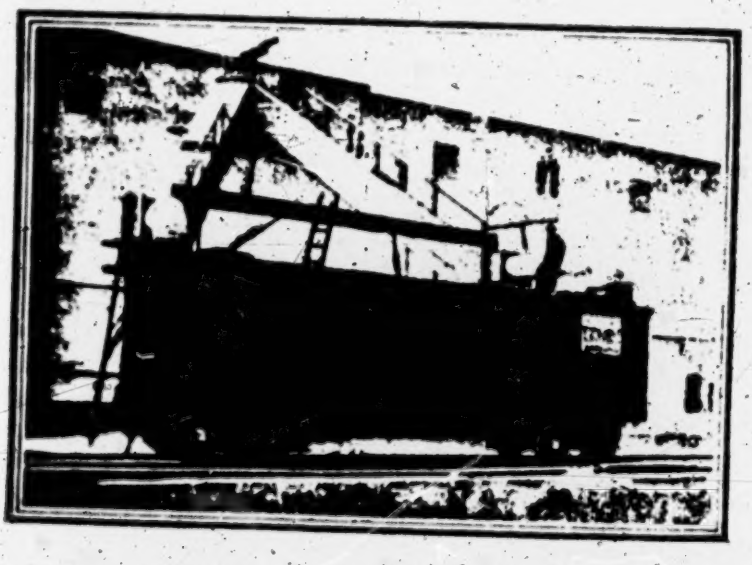
Encouraged by the success achieved in the Northern fruit fields, the Department of Agriculture turned its attention to the Georgia peach situation. In Georgia the peach crop, ranging from 1500 to 5000 carloads, ripens mostly in July,

and it reaches market practically within a period of four weeks. Evidently it is of great importance that the crop shall be distributed as widely as possible in order to prevent a glut in any market. This is made more difficult by the humidity usually prevailing when the fruit ripens. To prevent the growth of fungi, particularly the brown rot, which is more rapid when humidity prevails, it has been found necessary to cool the fruit quickly and uniformly. Formerly this was attempted by putting the freshly picked fruit in refrigerator cars, but in studying the temperature of the fruit at different points in transit the fact was shown that while the lower tiers were cooled quickly, the upper tiers cooled much more slowly. In consequence, the upper tiers continued to ripen after the lower tiers were almost at freezing point, and on arrival of the fruit at its destination the upper tiers of boxes contained a large proportion of overripe fruit while the lower tiers contained fruit which was in first class condition. It was determined that the reason for this was that the ice capacity of the cars was insufficient to cool the entire carload quickly enough to stop [fol. 195] ripening in transit. Experiments demonstrated the fact that with quick cooling the ripening in transit could be greatly reduced, the temperature would be maintained at a uniform degree, and the fruit would arrive in much better condition. Formerly the only way known to the growers to prevent excessive decay in transit was to pick the fruit before it was matured, which lowers the wholesomeness and attractiveness of the fruit, and hinders the widening of the market.

The Department's Refrigerating Car

A serious difficulty in the way of applying the principles evolved by the department's experts is that the growers have not yet reached the stage of having cooling plants, and the question of cost, where the plants could be used for such a short time each year is a serious one. The Department of Agriculture is having built a refrigerator car which is really a miniature refrigerating plant in a car, for use in the field where the fruit is picked and packed. Whether the fruit should be cooled before or after loading, and other details, are still to be worked out. Mr. Wm. A. Taylor, who has charge of the field investigation work, says that

the benefit to date is to emphasize the importance of getting the fruit quickly into an iced car. Formerly there was no hurry in handling. Sometimes, now, when the humidity and heat are great, shippers will not put the full load into the car, thereby reducing the total heat to be withdrawn from the fruit, and when the fruit reaches its destination the top tiers, which are ripest, are sold first.



Experimental Precooling Plant, Used at Los Angeles, Cal., to Lower the Temperature of Orange Before Shipment

Helping California Orange-Growers

It was after these investigations had satisfied the officials and scientists of the Department of Agriculture that they were on the right track, that they decided to take up similar work in California, where three-fourths of the orange-growers were united in the exchanges, enabling experiments to be carried on with a unanimity of purpose not attainable where every man was working out his own destiny in his own primitive way. Mr. G. Harold Powell was assigned to this work as pomologist in charge of fruit transportation and storage investigations. Under Mr. Powell's direction this work was carried on in all parts of the citrus belt, especially in Riverside, which has 20,000 acres of citrus fruits and is in the very center of the citrus industry. It was due, in fact, to Mr. J. H. Reed, a Riverside grower, that this work

was undertaken at all. And the orange industry certainly was worth succoring, for there were 75,000 acres devoted to it in California by between 5000 and 6000 orchardists, who annually send to market some 30,000 carloads of fruit, or about 10,000,000 boxes, worth at wholesale something like $30,000,000.

Under the scientific investigation by Mr. Powell and his staff of assistants, whose deductions were finally made from results noted in about 500 shipments of oranges to New York, handled in different ways, it was demonstrated that decay in oranges was due almost entirely to careless, ignorant and unskillful handling. It was shown that uninjured fruit under fairly favorable conditions was practically immune to decay. Once the tender skin of the orange was punctured or abraded, decay set in. Then Mr. Powell showed by actual tests that from 10 to 40 per cent. of the fruit was damaged either by thorn bruises, by the clippers used in cutting it from the trees, or by gravel in the boxes before it left the orchard. Growers found it hard to believe that the injuries shown them, usually slight, condemned the fruit to decay, but this was proved by hundreds of actual

A Typical Scene in the California Citrus Belt

(Palms and olive trees in the foreground, orange orchards in the middle distance, and snow covered mountains hemming the valley in)

[fol. 196] tests in which the growers and shippers participated. Several boxes full of the damaged fruit and several

others filled with fruit apparently perfect would be stored under conditions similar to those that would obtain in a car during transit to market, and at the end of two weeks most of the oranges in the damaged lot would be found decayed, while in the undamaged lot there would be no decay except in a very few specimens where the fungus growth would be found centered in a wound so small that it had been overlooked when the fruit had been selected for the test. By making actual tests like these, Mr. Powell compelled the growers to locate the blame for rotted fruit where it belonged.

With the cause of the trouble located, it became a question whether that cause could be eliminated. Naturally opinions differed. Some of the more progressive growers determined that there should be more care in picking and packing. In orchards where the proportion of damaged fruit had been from 10 to 30 per cent., that proportion was reduced with better methods to 2 or 3 per cent., and in certain instances to less than 1 per cent. The increased cost of the better work was but a trifle compared with the benefits.

One man who had invested over $100,000 in orange groves had been losing about 40 per cent. of his shipments through decay, and the trade had grown so suspicious of his brand that it did not care to handle it. He called on Mr. Powell, who told him that his methods were all wrong, and going with him from the tree where the fruit was being picked through every step of the work to the final shipment of the loaded car, he showed how improvement could be made. That man had the courage to stop all operations in the middle of the season, alter the equipment of his packing-house and the manner of handling fruit, and when he began again to ship, his fruit jumped to the top of the market and remained there for the entire season.

Formerly every grower picked and sent his fruit to the packing-house, if he belonged to an exchange, and was credited with the weight due him in each grade after the exchange had graded it. In the settlement he got his pro rata of the returns. Mr. Powell found that some growers turned in fruit free from wounds or abrasions; others turned in fruit 50 per cent. or more of which was damaged by the clippers or otherwise. He also found that some pickers did

not damage the fruit, while others jabbed, cut, and slashed half of what they handled. As a result of this discovery, the exchanges have taken charge of the picking; they furnish help when required, and it is all done systematically, with care, with some more expense, but with much better financial results.

[fols. 197 & 198] But, important as it was, this was only the first step. As the result of further investigations it was found that in the packing-houses, equipped often with complex and extensive machinery for grading, washing, brushing, packing, and boxing oranges, the fruit was further damaged by the processes used. Once convinced of this fact, a general overhauling and even rebuilding of the packing-houses began. During the past year alone, this work has been carried on at an expense of hundreds of thousands of dollars.

Another fact demonstrated was that the temperature of fruit at the time of shipment was of the greatest importance. Experiments to determine this were made on an extensive scale. It was shown that in a cool, dry atmosphere even injured fruit will carry a long distance before showing signs of decay, and uninjured fruit will keep indefinitely. The effect of loading fruit already at a high temperature from warm packing-houses into uncooled cars was carefully watched. Fruit delivered without being heated and kept as cool as practicable until loaded in the car, and other fruit artificially cooled to thirty-five or forty degrees before loading, were tested with significant results. These experiments were repeated until there was no possible question of the reduced amount of decay when the fruit was started on its long journey at a low temperature. For four seasons, with the co-operation of growers and transportation companies, test cars were sent on under these varying conditions as to temperature when started, often with an expert attending the train, carefully noting the temperature at frequent intervals, until the fruit reached its destination. The important deduction was that precooled fruit suffered much less decay than that not precooled. Another result was to explode the fallacy that it was necessary to keep fruit in the packing-houses for several days before shipping to "cure" it and improve its shipping qualities. The fruit is now shipped as soon as possible after it is picked, and so perfect is the system of the packers that if it be found

at ten o'clock that the fruit is coming in too fast, picking can be stopped in all the orchards before twelve.

Primarily, the gain to the most careful growers, according to estimates made by the best business men among them, from the more careful and intelligent handling of their fruit, has been from 25 cents to $1 a box; but to average the small growers with the big, and the careful with the careless, the average saving would be less. However, with an annual pack of 10,000,000 boxes, it would be needful to save but 10 cents on each box to make the benefit to the whole industry reach a round million dollars every year.

It is small wonder that the orange growers, packers, and shippers, and, in fact, the whole business community of California, are grateful to the Government and to Mr. Powell and his able associates for research work which inures so greatly to their benefit.

Secondarily, of course, the gain from these investigations must inure to all humanity; for their effect will be far-reaching. The work done in the interest of the orange-growers but followed the general lines Mr. Powell had laid down in the similar investigation he undertook to learn about the causes of decay in apples in cold storage. He is now investigating causes of decay in California peaches and table grapes.

Experimenting with Other California Fruits

California has nearly 8,000,000 peach trees in orchard, and in one year it has shipped East 1946 carloads of fresh peaches, the gross value of which was about $20,000,000. The shipments of table grapes from California now amount to about 3500 carloads a year, but the shippers say that if the fruit could be delivered in all parts of the United States in a perfectly sound condition the shipments might easily reach 10,000 carloads annually. This problem of transportation is now being solved. From the research work already accomplished it is pretty definitely settled that decay in grapes begins in split or broken berries, and that if there be no mechanical abrasion of the berry or stem due to improper methods of handling and preparing for market, the spores of the mold which causes decay cannot find lodgment for propagation.

Experiments with grapes, both as to cold storage and transportation, were continued all through the season of

1908. Experiments already conducted have demonstrated that with careful handling grapes will keep from two to four months longer than when handled under ordinary conditions.

With such promising beginnings, it is probable that the aid of scientific investigators will be invoked by growers and shippers of fruit and vegetables everywhere for the extension of markets and the annihilation of seasons in what now are "seasonable products."

[fol. 199] PLAINTIFFS' EXHIBIT No. 12

U. S. Department of Agriculture, Bureau of Plant Industry

Circular No. 26

B. T. Galloway, Chief of Bureau

Some Factors Affecting the Keeping Qualities of American Lemons

By Rodney H. True, Physiologist in Charge, and Arthur F. Sievers, Expert, Drug-plant Investigations, Bureau of Plant Industry

Chief of Bureau, Beverly T. Galloway.
Assistant Chief of Bureau, Albert F. Woods.
Editor, J. E. Rockwell.
Chief Clerk, James E. Jones.

Some Factors Affecting the Keeping Qualities of American Lemons.[a]

[a] "A series of physiological studies has been made in the Office of Drug-Plant Investigations by the writers of this paper to determine the relation between the present methods of bringing lemons into condition for the market and the keeping qualities shown by the fruit after shipment. These results are based on limited data, are advanced tentatively, and are subject to modification should further investigation require it. A strong demand for a report upon the results thus far obtained, coupled with the fact that they are likely to be of some service, seems to justify their publication.—B. T. Galloway, Physiologist and Pathologist, and Chief of Bureau.

Scope of the Investigation of the Keeping Qualities of Lemons

There is a prevailing impression among fruit handlers that American-grown lemons while possessing many points [fol. 200] of superior attractiveness are open to the objection that they are not long keepers. Assuming the correctness of this report, the source of this weakness demands a careful study of the whole lemon situation. The object of this investigation has been to get a clearer understanding of the processes through which lemons are put after picking, with special reference to the bearing of these processes on the behavior of the fruit in the packing houses, during transit, and after it has reached the market. This broadly outlined study has for its practical object the determination of conditions affecting the keeping qualities of the fruit after it has reached the market. The hope is also present that through the results obtained improvements in some of the processes investigated may be suggested.

It has been made clear by the work thus far accomplished that the keeping quality of American lemons is influenced by many factors, some acting on the orchard, some in the packing house, some in the cars during transit, and some at points far distant from California, that is, in the markets.

Losses of Lemons from Parasitic Diseases

Important among the factors causing the loss of lemons are parasitic diseases derived from the orchard. These operate not only there but, unless infected fruit is detected and discarded, also in the packing house, and even after the fruit has come on the market. The dreaded brown-rot (Pythiacystis citrophthora Smith) may stand as a type of destructive parasite. Since these organisms are usually virulent, the diseased fruits are in large part detected before shipment and form a conspicuous cause of loss in California.

Losses of Lemons from Blue Mold

A second type of trouble comes from aggressive organisms, such as blue mold, which, while not able to successfully invade a sound lemon, are fatal to fruits which have been injured by careless handling at some point in their history, or which are physiologically weak. Thus, while blue mold figures as an immediate cause of considerable loss, it be- [fol. 201] comes a source of danger chiefly after the fruit has been weakened by previous bad treatment. Mold invasion being a secondary phenomenon may appear at any time in the history of the fruit, but since the maximum amount of handling, and therefore the greatest danger from bad treatment, is found during the picking process in the orchard and in the subsequent sorting and handling in the packing house, a large proportion of the loss from mold is probably also found in California. Since shipping conditions may introduce violence and injury, a certain percentage of loss due to this cause and to such injuries and infections as took place during the last handling in packing will be met in the market soon after the arrival of the fruit. Thus the blue-mold situation becomes largely a question of proper care in handling. As the losses due to blue mold are to a large degree dependent on the percentage of lemons having a punctured or otherwise ruptured epidermis, the toughness of the outside cuticle becomes an important factor in fruit preservation. The results of mechanical tests of the ease of puncture as affected by the packing-house processes are summarized later in this circular. Since injury in the handling and shipment of lemons is a matter of study in the Office of Field Investigations in Pomology of this Bureau, this general subject is not considered here.

Physiological Weakness of Lemons

Another possible seat of trouble may lie in weakness caused by the processes through which the green fruit is put in order to color it for the market, or in the conditions under which it is stored, either at the place of production or at the point of consumption. This line of investigation calls for a study of lemon houses and their operations,

with special reference to such processes as seem likely to weaken the fruit.

Methods of Preparing Lemons for Market

A preliminary study of the situation has developed the fact that lemons come on the market with widely differing histories.

[fol. 202] (1) Some are sufficiently colored when they are picked from the tree and are shipped to the market as quickly as possible. The so-called "tree-ripe" lemons are usually segregated and go on the market as inferior fruit, it being generally agreed that tree-ripe lemons do not have as good keeping qualities as the fruit which is picked green and colored artificially.

(2) "Sweated fruit" is picked green when the proper diameter is reached, and colored rapidly by storage in moist, tight, sweat rooms or sweating tents in which a high temperature is maintained, usually by means of oil stoves burning in the room with the lemons or in a cellar-like room below the fruit and separated from the storage room by slatted floors. The humidity and heat, and perhaps carbon dioxid and other gaseous products of combustion, acting together bring about a rapid coloration of the fruit. Sweating is usually resorted to only when the price of lemons is high and a rapid marketing of the crop is desired. It is generally agreed among lemon growers that sweated lemons are less likely to keep than those colored more gradually at lower temperatures. Since the conditions maintained in sweat rooms are highly unnatural and the result is obtained in a most unnatural way, some attention has been given to the physiological factors involved in sweating.

(3) By far the larger part of the lemon crop is picked when the desired diameter of the fruit is reached, and this is colored up by "curing" at low temperatures in the packing houses. In some places where the water loss from the fruit is likely to be relatively easy to control, an open floor covered by a roof is sufficient for a permanent storage structure. In order to enable the manager to modify conditions to suit the needs of the individual lots, the lemons,

in boxes or trays, are piled up in carload lots, and each pile is covered by a heavy canvas tent, of which the sides and ends may be raised or lowered at will. In those regions where water loss is less readily controlled, the storing house is boarded up with the usual walls and ends. To secure uniformity of conditions with even greater ease, [fol. 203] some growers have made use of cellars under the houses. Lemons colored by this slow "curing" process may remain in the tents or cellars as long as six months or more if market conditions require it, but usually fruit is marketed much sooner.

In grading and packing the fruit for market some lemon houses handle the sweated and tent-cured sorts separately, but this is not the invariable rule.

Physical Characteristics of the Different Types of Lemons

Lemons are known to be a most variable fruit in their physical characteristics. Not only is this true of trees of any given variety, but in some cases it is also true of the different fruits taken from the individual tree. The manner of handling water and fertilizers is commonly believed to be of great importance in getting smooth, well-shaped lemons. The lemon varies in general from a barrel shape to an almost spherical form marked by more or less pronounced protuberant ends. Thick and conspicuous ends detract from the value of the fruit. The best size of lemon weighs on the average 120 to 135 grams. Of course size is not the only factor which determines the weight, much depending on the rind, quantity of juice, and general solidity of the fruit. The most desirable sizes of lemons average 300 and 360 to the box.

There are usually three grades of lemons, known as "fancy," "choice," and "standard." The grades depend on the general texture of the fruit, the form, and the color. The sizes vary from 180 to 540 to the box, but few lemons are packed larger than the 240 or smaller than the 490 per box size. The better grades are mostly made up of the fruit of fine texture and of good form picked when green and colored either by slow curing in tents or by sweating. The tree-ripe fruit is less commonly used for the finer select grades, since many question its keeping quality. In

some packing houses it goes largely into an inferior grade, and at some seasons of the year when the fruit is quite [fol. 204] small from 400 to 500 are packed in a box. A very small percentage of fruit constitutes the grade known as "sinkers," or "heavy lemons." This type derives its name from the fact that the fruits sink in water when being washed. They are usually spherical in shape and quite small, with extremely thin rinds and a relatively large amount of juice.

The green fruit after it is properly cured, either by sweating or by the slower tent process, possesses a rich lemon-yellow color which is seldom found in the tree-ripe fruit.

There is a wide variation in the texture of lemons, which is currently believed to be influenced by orchard conditions and the season of the year. As a rule, large, overgrown fruit has a rougher texture than smaller fruit. During the curing process the rind is smoothed down considerably, and the texture is improved. Tree-ripe lemons usually have a smoother texture than the green fruit.

The rind consists of the external epidermis and a well-developed underlying layer of soft, spongy, white tissue. This layer of tissue contains a considerable quantity of water, much of which evaporates during the curing of the fruit, causing a considerable shrinkage in the thickness of the rind. It is for this reason that the spongy layer of the green, freshly picked fruit is, as a rule, thicker than that of the tent-cured lemons. Individual lemons display great variations in the thickness of their rind, a condition which it is difficult to recognize from the general external appearance of the fruit. It appears that good, sound, normal-sized fruit, with smooth or medium texture, as a rule, has a thinner rind than the rough and oversized sorts. The rind of green fruit varies from one-eighth to five-sixteenths of an inch in thickness and averages about one-fourth of an inch. As stated previously, the tent-cured and sweated fruit averages somewhat less, while the "tree-ripes" usually run from one-eighth to three-sixteenths, and [fol. 205] "sinkers" vary from about one-sixteenth to one-eighth of an inch, due to the extreme reduction of the spongy layer.

The seed content of the California lemons is very small, indeed. A large majority of the fruit is entirely free from

seeds. Now and then one finds a lemon that contains as many as a dozen seeds, sometimes all developed, but more often only partially so. They occur in all grades and varieties of fruit, but it appears that they are found more frequently in lemons of low grade. It is said by some growers that orchard conditions as regards the soil and method of cultivation, as well as the general condition of the trees, have an important bearing on the presence of seeds. It has been noticed that the fruit from some localities displays a greater tendency toward seed production than that from others.

The juice constitutes from 30 to 55 per cent of the total weight of the lemon, varying to a considerable extent with the thickness of the rind and the general solidity of the fruit. In the "tree-ripes," "sinkers," and cured fruit the percentage is higher than in the green, newly picked lemons, for the reason that the latter have more water in their rinds. The juice obtained by expression contains a considerable quantity of mucilaginous material, which gives it a cloudy appearance. Great difficulty is found in removing this material; in fact, all methods of clarifying tested fail to make the juice perfectly clear.

Besides the citric acid, to which the sourness is chiefly due, tartaric and malic acids are present, but in such small quantities that they are probably negligible as to their effect both on the behavior of the fruit itself and on the acid determinations. The specific gravity of lemon juice shows a narrow range of variation. By far the majority of determinations give results approximating 1.035. Numerous samples have given results as low as 1.026 and still more as high as 1.04. It was expected that the specific gravity of the juice would be governed by the acidity, but this was borne out only in a partial way. It was found that either a decidedly high or a decidedly low percentage of acid is [fol. 206] indicated by a correspondingly high or low specific gravity. This was especially true when the acid content was higher than usual. Small differences in acidity are not indicated by the specific gravity with any degree of certainty, the variations in the quantity of mucilaginous material perhaps hiding any change which might otherwise be indicated. Experience has shown that a difference of

less than 1 per cent of acid can not be foretold by a specific gravity determination of the juice.

Chemical Characteristics of Lemons

The chemical study of lemons as regards acid, sugar, and water content has been undertaken in the hope that it would lead to information which would offer some suggestions for improving the handling and curing of the fruit.

Acids

The acidity of the lemon is considered by some to be an important factor in determining its keeping quality, it being asserted that lemons containing a high percentage of citric acid resist decay for a longer period than lemons of a lower acid content. The results thus far obtained show the average acid content of the different sorts of fruit calculated as citric acid to be as follows:

	Percentage of acid in juice
Dark-green fruit (picking stage)	6.08
Light green fruit (picking stage)	6.14
Tent-cured fruit (marketable stage)	6.80
Sweated fruit (marketable stage)	6.45
Tree-ripe fruit	5.91
"Sinkers"	5.68

These results were obtained from a large number of lemons taken from various packing houses and they indicate that there is a difference of a trifle less than 1 per cent of acid between the best keeping grade of fruit, the tent-cured; and the "tree-ripes," which represent the poorest grade on the market. This deficiency seems too small to account for the marked difference in the keeping quality of these two grades of fruit. Other points of difference much more [fol. 207] striking seem to indicate that other factors have a greater bearing on this problem than the acid content. It has been found, furthermore, that tree-ripe lemons showing an average of 6.88 per cent of acid, which is exceptionally high, when stored decay fully as quickly as other fruit of a lower acidity. Sicilian lemons of a good grade bought on

the open market showed on the average 6.45 per cent of acid. This is less than is found in much California fruit of a corresponding grade.

In order to determine whether the curing process has any marked influence on the acidity of the lemon, a series of determinations was made during February and March, 1908, beginning with the time of picking and repeated at weekly intervals until the fruit was ready for market, as follows:

	Percentage of acid in juice
February 3	6.32
February 10	6.42
February 17	6.43
February 24	6.29
March 2	6.07
March 9	6.46
March 16	6.60
March 23	6.70
March 30	6.73

It will be seen that the percentage of acidity shows a tendency to increase, due chiefly, perhaps, to the water loss accompanying the curing process.

Sugars

The study of the sugars has thus far been confined to estimating the quantity of reducing sugars in the juice of the dark green, light green, and tent-cured fruit. An attempt has also been made to trace the development of reducing sugars as the fruit develops in the orchard. The tests which were made during seven stages of development, the last three stages representing the dark green, light green, and tree-ripe stages, respectively, showed the following percentages of sugar in the juice:

	Percentage of sugar in juice
First stage	1.63
Second stage	1.27
Third stage	1.38
Fourth stage	1.19
Fifth (dark green) stage	2.66
Sixth (light green) stage	2.64
Seventh (tree-ripe) stage	2.68

[fol. 208] These analyses show that there is relatively little change in the sugar content during the early history of the fruit and that the principal development comes after the fruit has almost reached its full size and is beginning to ripen.

Sugar determinations were also made upon fruit undergoing curing in the curing tents. The estimation was made during February and March, 1908, once a week from the time the fruit was picked until the fruit was ready to be marketed. The results show a very low percentage of sugar compared with the fruit above studied, with no definite trend toward either increase or decrease as the curing proceeds. The following tabulation summarizes the analyses:

	Percentage of sugar in juice
February 3	1.18
February 10	1.36
February 17	1.17
February 24	1.38
March 2	1.02
March 9	1.19
March 16	1.19
March 23	1.09
March 30	1.11

Water Content

Some investigations were begun relative to the loss of water from lemons while undergoing curing both by the tent-curing method and by sweating. The green fruit as it comes from the orchard has a rather thick rind with considerable spongy tissue. During the curing this tissue shrinks to a considerable extent and the rind becomes somewhat thinned and toughened. This change is believed to be due chiefly to the evaporation of water from the rind. In order to determine the extent of this evaporation, both as to the total amount evaporated and the stages of the curing process during which most of it occurs, a convenient quantity of lemons was placed in a separate box and kept in a tent with about a carload of other fruit and weighed once a week. The lemons were divided into two lots by a partition through the box, the bottom of one-half being

lined with paper. This was done with the object of determining the extent to which evaporation is retarded by lining [fol. 209] the boxes with paper a practice which is sometimes resorted to during extremely dry weather. The results obtained during December, 1907, and January, February, and March, 1908, are shown below:

TABLE I.—Loss of Water in Lemons While Curing in Tent 31.

Date	Boxes lined with paper		Boxes without paper lining	
	Weekly loss Per cent	Total loss Per cent	Weekly loss Per cent	Total loss Per cent
December 16				
December 23	1.41	1.41	1.44	1.46
December 30	1.07	2.47	1.13	2.55
January 6	.97	3.42	.98	3.50
January 13	1.17	4.45	1.20	4.68
January 20	1.45	5.97	1.64	6.23

TABLE II.—Loss of Water in Lemons While Curing in Tent 59

Date	Boxes lined with paper		Boxes without paper lining	
	Weekly loss Per cent	Total loss Per cent	Weekly loss Per cent	Total loss Per cent
January 27				
February 3	1.09	1.00	1.04	1.04
February 10	.92	2.00	.97	2.06
February 17	1.10	3.07	.98	3.23
February 24	.87	3.94	.99	3.97
March 2	.90	4.77	.97	4.94
March 9	1.49	6.21	1.59	6.41
March 16	1.27	7.40	1.30	7.67
March 23	1.50	8.75	1.50	9.00
March 30	2.95	11.50	2.77	11.57
April 6	2.30	13.59	2.22	13.54

The following tabulation shows the percentage of total water loss during twenty-two days from three sorts of fruit:

TABLE III.—Loss of Water in Lemons while Curing for Twenty-two Days

Sort of fruit	Boxes lined with paper	Boxes without paper lining
	Per cent	Per cent
Dark green	3.03	3.47
Light green	2.86	3.44
"Tree-ripe"	2.73	3.11

[fol. 210] These experiments show that the loss of water from the fruit does not increase or decrease week by week with any regularity. Some weeks show a decided increase and are immediately followed by a corresponding decrease. The explanation for these irregularities can probably be found in existing weather conditions, especially as regards humidity and wind. A very humid day would cause a decrease in the evaporation from the fruit, whereas a high wind, even though not exceptionally dry, would penetrate the usual form of packing house and convey the moisture away through various doors, cracks, and other openings to such an extent as to increase the water loss from the fruit. Careful manipulation of the tent and good judgment as to when and how much to ventilate the fruit would doubtless do much to minimize these fluctuations.

In comparing the results shown in different tents it must be borne in mind that the respective location of the tents has a very material effect on evaporation. A tent which is in close proximity to the open side of the house or to doors and corridors where currents of air can circulate around it would necessarily show wider fluctuations in its evaporation than a tent located in the center of the house and well protected from external atmospheric changes.

In sweat rooms, where the fruit is kept at a much higher temperature, very different conditions are met with. Owing to the high heat with lower relative humidity the evaporation takes place much more rapidly. The total percentage of water evaporated at different intervals from the fruit in such a sweat room, the fruit being sweated twenty days, a period considerably longer than is usually required, is shown below:

	Percentage of water evaporated
February 23	
February 25	0.85
February 26	2.10
February 27	2.76
February 28	3.40
March 1	3.84
March 5	4.60
March 9	6.10
March 13	8.05
March 16	9.25

[fol. 211] Keeping Qualities of Lemons

To anyone who has carefully examined lemons as they come freshly cut from the orchard or as they hang on the tree it is clear that the fruit is oftentimes extremely variable in size, shape, and texture. It is quite generally held that lemons of a certain form are likely to prove good keepers, while those having other forms are liable to decay early. The unsymmetrical, usually undersized lemons grown in the bright sun are thought to be poor keepers, while those from the portions of the tree where the fruits are well enveloped by leaves and have a good size and symmetrical form are believed to have good "life." It has not been practicable thus far to experimentally test these suppositions, but it seems from what has been done that there is a considerable degree of variability in the keeping qualities of lemons from the same orchard and probably from different parts of the same tree.

Relation to Structure

Certain structural features, viz, those belonging to the rind, seem to be especially important in this connection. The rind, which consists of a layer of white, spongy packing tissue having a very variable thickness, is covered on the surface by the epidermis. This covering consists of a layer of cells so modified chemically as to be almost impervious to water. The degree of imperviousness is greatly increased by a dense outer cuticle of a very resistant material which is practically waterproof. There are a vast

number of small pores (stomata) in the epidermis, through which gases enter and water, as vapor, escapes. These stomata open into small chambers in the outer part of the rind.

Additional characteristic structures, known as oil glands from the substance which is formed in them and which they retain until the skin dries up, are found embedded in the outer part of the rind at different distances from the epi- [fol. 212] dermis. The oil in these glands is a volatile product, giving the characteristic lemon odor to the fruit.

As has been already indicated, the losses assigned to blue mold are in a very large measure due to the development of the fungus following injuries. It is probable that the true blue mold can not penetrate the uninjured epidermis of a healthy lemon, but when a break occurs it is able to enter and bring about the characteristic rot. The development of the defensive outer layers of the rind is a matter of great importance in view of the ease of producing slight, but fatal injuries to the fruit.

To test the strength of this defense, a simple puncture experiment was devised. It consisted essentially of an apparatus so constructed as to enable one to apply known and regulated pressure to a blunt point in such a way as to get the amount of pressure needed to force the point through the epidermis. The needle tip was found to puncture the epidermis and bring oil to the surface with more readiness when it was applied directly over an oil gland—that is, on the surface of one of the projecting papillæ—than when applied in the sunken place between these. It appears that the nearer the oil glands are to the surface the greater the ease of rupture. In tree-ripe lemons it seems from the evidence thus far gathered that the outermost glands are likely to be less protected than in the fruit which is picked green. This would seem to indicate that tree-ripe fruit might show a greater loss from mold due to injury than fruit picked while green.

In a similar study of tent-cured fruit, a resistance markedly greater than in tree-ripe lemons was shown. Indeed, the resistance to puncture in tent-cured fruit seems to be double that of tree-ripe lemons. This difference is prob-

ably due in part to other factors than the absolute strength of the walls of the epidermis, but the result represents practically the relative liability to damage dependent on the structure of the outer tissue of the lemon. It was [fol. 213] found that the tissue beneath the tough outer epidermis was able to offer very little resistance when the point of a needle had passed through the epidermis.

Lemons are frequently subjected to steady pressure of various degrees of intensity, and are preserved from injury by the general strength of their tissues throughout. Under these cidcumstances, the white, pulpy packing tissue between the epidermis and the segments plays an important part. The thickness of this tissue varies very widely. In the so-called "sinkers," which form a case of an extreme reduction, this tissue forms a very inefficient protection against injury. Hence, "sinkers" might be expected to be poor shippers.

Texture

The relation of coarseness of texture to losses is not very clearly marked. In general, coarse lemons have a strong development of rind tissue. But many smooth lemons are equally well protected. The thickness of the epidermis and the consequent ability of the lemon to withstand wear is well tested in the box during shipment, when, as frequently happens, the jar of the car in stopping and starting is transmitted to the fruit in the box. The result follows that the fruit is "rasped" on rough surfaces of the shook, particularly of the ends and middle crosspieces when they are not planed.

Method of Curing

The keeping qualities of different types of lemons also depend largely on the method of treatment to which they are subjected to bring them into marketable condition. Although the inherent condition of the fruit, due partly to its early history, will determine its ability to resist decay to some extent, there is reason to believe that the method of curing is an important factor in determining the life of the lemon on the market. The lemon growers as a rule agree that the so-called sweating process of curing fruit has a deteriorating effect, although no definite tests have been [fol. 214] made which would fully substantiate this belief.

The sweating process is resorted to only when the briskness of the market necessitates a rapid coloring of the fruit. The grower, although he realizes the possibility of endangering the quality of his fruit, has at present no other method of curing lemons rapidly, and is therefore compelled to make the most of the process.

The tree-ripe fruit, as has been stated elsewhere, is thought to be inferior to the tent-cured sort, and is kept in the packing house as short a time as possible. After being washed and graded, it is immediately put upon the market, as a rule, for unnecessary delay in the packing house will only shorten its life on the market.

The point to be investigated, therefore, is the relative keeping qualities of these three sorts of fruit. With this object in view, a limited series of storage tests was made in the spring of 1908.

All the fruit was shipped to Washington, D. C., and stored. The entire lot was carefully examined once a week for three or four weeks, and then every two weeks during the remainder of the test. Careful note was made of the form of decay which was met with, in order to get more information as to what varieties of decay are most destructive after the fruit arrives on the market. The following are the summarized results:

Table IV.—Loss of Lemons from All Forms of Decay During Sixteen Weeks in Storage

No. of lot	Tent-cured fruit Per cent	Tree-ripe fruit Per cent	Sweated fruit Per cent
1	39.8	68.0	...
2	41.5	49.7	72.0
3	39.0	54.0	23.1
4	34.0	69.5	...
5	[a] 23.5	[a] 39.0	...

[a] Two weeks less in shortage.

[fol. 215] Table V.—Percentage of Total Loss of Lemons Due Apparently to Blue Mold [a]

No. of lot	Tent-cured fruit Per cent	Tree-ripe fruit Per cent	Sweated fruit Per cent
1	55.0	48.5	....
2	47.6	52.5	72,0
3	55.0	43.8	62.8
4	76.0	46.3	....
5	50.0	69.6	....

A careful study of Table IV will indicate clearly the superiority of the tent-cured over the tree-ripe fruit. In each of the five lots this point is well brought out. It will be further noticed that the amount of rot in the tent-cured fruit is very nearly the same in all five lots (if lot 5 had been kept two weeks longer it would probably have shown nearly 30 per cent of decay), thus showing that there is no material difference in the fruit which had been obtained from the coast, the foothills, and the inland districts.

The results obtained from sweated fruit indicate a rather peculiar condition, which it is impossible to explain at present. Neither lot was sweated as thoroughly as is the custom, nor were both lots sweated exactly alike, which facts may account to some extent for the great difference in the results. The variation in decay is not the only point, however, in which these two lots of fruit differed. Lot 3 was excellent fruit, with a soundness, texture, and color well worthy of the best fancy grade, while lot 2 was, almost from the beginning of the tests, of such unpresentable appearance as to make it practically unmarketable. The causes underlying these great differences are not understood at present, but the results invite a more extended study of the matter.

[fol. 216] The Most Serious Causes of Decay of Lemons

An important phase of the whole situation as regards keeping qualities is the matter of the different forms of

---

[a] In these figures the first two weeks in storage are not included, for the different forms of decay were not registered separately. During the early weeks the blue mold predominated, owing perhaps to the mechanical injury received in the packing house and in transit.

decay met with in these tests. In the first few examinations no definite record was kept of each form, but the blue mold predominated, a condition which becomes prevalent after much handling of the fruit, as is the case in sorting, packing, and shipping. After a few weeks it became apparent, however, that a different form of decay was beginning to appear, which suggested the necessity of keeping a close watch on the relative growth of each form. Table V shows the percentage of the total rot which was apparently due to blue mold when seen. Considerable difference is found among the various lots. The amount of care exercised in handling the fruit at the different places where it was obtained and the fact that it was not all shipped over the same route might go far in explaining the difference.

As many as five apparently distinct types of slow disease of the rind were seen, oftentimes having very striking form and color characteristics. These were not studied, since, apart from injured appearance, the loss due to them directly appeared to be but small. They may, however, possess greater significance by opening the way for the more actively destructive powers of the mold.

Finally, there is a very prevalent form of decay resembling in appearance and in odor the virulent brown-rot of the citrus region. The conspicuous symptom is a brownish discoloration, which may appear anywhere on the lemon, followed by softening, discoloration, and a spreading of the affected area, which in time involves the entire lemon. The progress of the decay can be noted by the brown color and disintegration of the tissues.

The following table shows an interesting condition as to the periods when the greatest and smallest amount of decay takes place:

[fol. 217] Table VI.—Decay in Lemons in Storage for Different Periods

Time in storage Weeks	Lot 1 Tent-cured fruit Per cent	Lot 1 Tree-ripe fruit Per cent	Lot 2 Tent-cured fruit Per cent	Lot 2 Tree-ripe fruit Per cent	Lot 2 Sweated fruit Per cent
On arrival	1.6	10.0	0.0	5.4	3.1
1	2.9	17.4	.5	5.6	15.7
2	2.2	5.5	1.9	3.5	13.2
3	1.8	1.0	.0	2.0	3.4
4	3.1	4.8	.4	2.2	3.6
6	3.2	10.8	.0	1.4	3.7
8	5.0	12.6	1.5	6.8	2.2
10	7.2	14.9	2.7	6.8	16.3
12	8.4	16.5	2.0	12.2	24.8
14	14.0	15.3	5.4	11.0	19.6
16	13.4	....	6.1	....	27.7

Time in storage Weeks	Lot 3 Tent-cured fruit Per cent	Lot 3 Tree-ripe fruit Per cent	Lot 3 Sweated fruit Per cent	Lot 4 Tree-cured fruit Per cent	Lot 4 Tree ripe fruit Per cent	Lot 5 Tree-cured fruit Per cent	Lot 5 Tree-ripe fruit Per cent
On arrival	0.0	0.8	0.0	1.2	4.8	2.8	4.1
1	3.3	2.8	2.1	1.3	4.2	6.8	8.8
2	.0	.0	1.0	4.3	3.0	1.8	2.7
3	.6	.0	.7	2.2	4.9	.9	1.6
4	.8	.3	1.1	.5	4.2	.4	1.2
6	2.4	.9	.0	1.8	3.9	1.4	2.8
8	3.9	5.8	2.9	2.3	17.2	.9	2.1
10	5.1	9.0	1.12	4.8	22.1	3.3	4.4
12	7.3	7.8	3.4	4.5	17.3	3.5	6.3
14	8.6	14.0	1.9	7.4	27.6	4.1	13.0
16	14.2	14.2	2.4	9.7	....	....	....

The principal thing to be observed here is the interval of minimum decay occurring about three or four weeks after the arrival of the fruit in storage. After this more or less extended period the decay often increases rapidly from week to week. When it is remembered that the decay during the first few weeks was mainly due to blue mold, it seems reasonable to suppose that the period of decreased decay fol-

lows after the majority of the fruit injured mechanically during curing and packing and while in transit has suc- [fol. 218] cumbed to the attack of the blue-mold fungus. In other words, it constitutes the period of the greatest freedom from any form of decay. The fruit later shows signs of weakening, however, and collapse, the symptoms of which have already been discussed, then becomes the chief source of loss. The lemon thus weakened again offers an opportunity for blue-mold attack. It must be remembered that these observations were made on tests of a comparatively small quantity of fruit. Experiments along this line will be continued on a larger scale.

Conclusion

From the work thus far accomplished certain general conclusions seem to follow, but in indicating them it should be distinctly borne in mind that they are advanced in a tentative way and may be more or less modified as these investigations progress. It is probable that the keeping quality of American fruit in the market is affected by the manner of handling in the course of its history, especially during the later stages of handling in California, during transit, and in the wholesale houses. Rough handling results largely in cases of blue mold. A well-marked physical breakdown, resulting apparently from brown-rot infection, seems to cause most serious losses after the fruit has been stored for some weeks or months.

In a series of experiments designed to demonstrate the communicability of this disease under the conditions of storage present, negative results at first seemed to point to a physiological breakdown, but a study of the decaying lemons by Mrs. Flora W. Patterson, Mycologist of the Bureau of Plant Industry, revealed the presence in practically all cases of fungal hyphæ resembling those of Pythiacystis, the brown-rot. Investigations in the office of Fruit-Disease Investigations, under the direction of Mr. M. B. Waite, Pathologist, have demonstrated the presence in much of the diseased fruit of the wither-tip organism, Colletotrichum. One or both of these organisms, and perhaps others also, are therefore apparently the cause of the brown- [fol. 219] ish rot which appears in the lemons after they have been some weeks in storage. Infection probably takes

place in California and the disease remains undeveloped until weeks after arrival in the eastern market.

Approved:

James Wilson, Secretary of Agriculture.

Washington, D. C., May 24, 1909.

PLAINTIFFS' EXHIBIT No. 13

Proceedings of the Twenty-second Annual Meeting of the Florida State Horticultural Society, Held at Daytona, May 18, 19, 20 and 21, 1909

Compiled by the Secretary, Published by the Society

DeLand, Fla.

E. O. Painter Printing Company, 1909

Packing and Shipping Citrus Fruits

Modern Methods of Packing Oranges

By Lloyd S. Tenny, Pomologist

MR. PRESIDENT, LADIES AND GENTLEMEN: More than ever before in fruit growing, the quality of the product as it arrives on the market is of first importance. No matter how fine the fruit may be in the orchard or packing house if it reaches the market in a decayed or poor condition, the grower ultimately loses money. The methods of growing [fol. 220] the fruit are of prime importance for unless it is well grown, of fine quality on the tree, free from disease and insect pests, there is no hopes of it ever being in first-class condition when it reaches the market. But it is not sufficient to have the fruit in perfect condition as it hangs on the trees ready for the harvest. The processes of harvesting and packing are almost equally important with the methods of growing for unless these methods are correct, the handling of the fruit in packing may be the means directly or indirectly of much loss from decay in transit or on the market. The work of the department of agriculture in California and Florida on better methods of

packing oranges is sufficiently well known for me not to dwell long on these results. The paper which was read at the last meeting of this society at Gainesville gives the data in full to that time. Suffice to say that the experiments all lead to the belief that the methods of picking and packing the oranges very clearly indicate what the carrying quality will be.

The aim of our work in Florida during the past season has been rather more practical than experimental. We have selected certain picking gangs and packing houses where we have had virtually full control of the different processes to determine if careful methods can be adopted on a commercial scale and to learn how the cost of the different processes under these conditions compare with the rougher methods. Chief, too, in our work, was a desire to know how the fruit handled in this improved way carried to market.

This work is not completed as yet, and I shall reserve until some future time the very encouraging results which we obtained. We want you to know, however, that it has been possible to train a picking gang to do good work. It has been possible to eliminate much, if not all of the rough handling in the packing-house and best of all we found that fruit picked and packed under our own supervision had splendid carrying quality and held for two weeks after [fol. 221] reaching the market with surprisingly little decay.

I should like to spend more time on this subject tonight but we want to take a long trip and study some modern methods and modern machines used in packing oranges. The pictures which you will see will not all represent ideas which you as orange growers of Florida can incorporate into your business, but where this is true, you may find some suggestions which under changed conditions will be of service to you.

(Following Prof. Tenny illustrated the different packing houses in California with stereopticon views which were very interesting and we regret we cannot show the pictures here.—Secretary.)

Discussion

Mr. Tenny: A statement made this afternoon was slightly misleading. At this time of the year you would

see nothing but clean culture but lately there has been a tremendous tendency to allow the grove to become covered, and uncultivated the greater part of the year.

Just now, at the beginning of your rainy season it is just finishing the rainy season in California. The land should all be cultivated at the present time. There is thorough cultivation with irrigation possibly once a month during the entire summer period while there is no rain whatever. It would not be surprising if they did not have a drop of rain for the next three or four months. They irrigate very heavily when necessary and as soon as it is possible to harrow they do so and keep this ground for about six or eight weeks, thoroughly pulverized. This is continued until usually about September; possibly October. The rains are beginning then but only slightly, and before the rains really start in they get the ground in proper shape and put on a cover crop, mostly the velvet bean and other things of that kind. They come up and grow rather rapidly during October, November and December. Then it depends largely on [fol. 222] the personality of the grower, but usually before the 1st of February the ground is plowed and from that time it is clean cultivated.

The wet season with them happens to be in the winter time; in your case it is the summer time. They plow rather deeply and cultivate deeply; six or eight inches.

Mr. Kilgore: How deep is their soil? Very deep?

Mr. Tenny: Very deep; 200 or 300 feet. It is made from the wash from the mountains, then hard pan and sub-soil in places that are hard.

I agree thoroughly with what Mr. Hart stated this afternoon. From his standpoint and from the standpoint of a few packers in Florida the methods that are pursued in California look rather rough. They handle an immense amount of business, however, and it is impossible to give it the same time and attention that a small packer can give his fruit, if he will. And their orange will stand more than the Florida orange will. But as an average, I think Mr. Hart will agree with me, their methods are more careful than the average methods in use in Florida. Of course, Mr. Hart's methods as well as a very few others in Florida, are more careful than many in California.

When we first started out in California, in many places we found the fruit was elevated and allowed to run down

by gravity through the various machines. This made a tremendous amount of rough handling. The first thought that presented itself to Mr. Powell and myself was that this probably had something to do with the decay. We took up the dropping experiments and got very excellent results. When we came to Florida, for the moment I did not begin work on dropping oranges. I began to look for clipper cuts and found comparatively few, and long stems, but there were few of those. At the close of the first year we began dropping experiments and the results were startling. Sometimes we had as high as 70 per cent decay where oranges were dropped 18 inches, while oranges not dropped showed only 3 or 4 per cent decay at the end of two weeks.

[fol. 223] We find there is a great deal of difference shown in the effects of dropping on oranges. Some oranges will stand a considerable amount of dropping while others are much more susceptible. It may be due to the fertilizer, climatic conditions: I don't know just what it is. They may have a thin skin or a thick skin, but it is a fact that some will go to pieces almost immediately, while others will not show the effects for a much longer time.

By E. H. Mote

MR. PRESIDENT, LADIES AND GENTLEMEN: In discussing this subject, I wish to refer to some of the problems that must be solved before we begin to pack the citrus fruits. I once heard a clergyman, who was debating the subject: "How to Read the Bible," begin his oration by saying: "You must first have a Bible to read." He had bibles to sell. We are fruit growers—and I wish to emphasize the fact that we must first grow the right kind of fruit, before successful packing is possible.

In our discussion of this question at the last meeting of this society, Mr. W. S. Hart began an excellent paper on this subject by saying: "We must begin by proper cultivation, fertilizing, etc."

I would place the beginning further back than that. I would begin with the selection of the proper locality, and the preparation of the soil, before a tree is planted, or cultivation and fertilizing begins. The question of drainage, management of subsoil, to insure the necessary circulation of air among the root system of the tree during the grow-

ing season is the surest foundation for successful cultivation that will insure the production of a class of fruit that will have all the excellent qualities of pulp and rind necessary to successful packing of fruit that will carry well, and command a price at destination.

I recall a personal experience, some years ago, when I bought the fruit in two groves, aggregating some eleven [fol. 224] thousand boxes, which broke down and began rotting before I could get it out of the packing house. One evening I left the cover off of fifty boxes, and found, next morning, an average of ten to the box that were already showing signs of immediate decay. To all outward appearance, the fruit was perfect—but there was a radical defect in production that made it impossible to get it to market in good shape—even by the most painstaking care in handling.

I also call to mind that a few years ago—in the neighborhood where my own grove is located, that the fruit "creased" so badly that a large percent was lost. The fruit now produced in both the localities referred to, has been improved by proper fertilizing, drainage and cultivation, so that no difficulty is experienced in putting it into market. Of course when a grove is already planted and in bearing, these precautions cannot be taken in advance; but, even then, much can be done to remove the evil, by looking well to the cause; and, as far as possible, remedy the natural defects in the soil; so as to bring the fruit into the packing house in a possible condition to be benefited by good packing. In this connection I wish to call your attention to the fact that there is a promising outlook for the successful cultivation of the lemon in Florida. We have all the congenial environment for this valuable citrus fruit, that can be found in any country now producing the lemon commercially.

My own experiments in its growth—while not sufficiently extensive to make a hard-and-fast opinion expedient; yet, I have produced some samples of this fruit that are, to say the least, very encouraging. It will be remembered that in California the early efforts to cultivate the lemon promised to be a total failure—not because the natural conditions were wanting, but simply because the growers there did not know how.

The present value of the lemon groves now in that State, shows conclusively that it pays to learn how; to so combine natural advantages which we have in abundance with the [fol. 225] habits of this fruit, in order to make its cultivation here very profitable. I believe it will be as easy for us to succeed with the lemon in the near future, as it has been to succeed with the grapefruit in the recent past. It may, perhaps, be properly said that the keynote to successful packing and shipping may simply be in "knowing how." We certainly have much yet to learn as well as considerable to unlearn. We are fast learning the fundamental principles of cultivation, and are making rapid strides in producing the quality of fruit that can be successfully put into profitable markets; and, it only remains for us to learn the detail of the most perfect method in harvesting and packing. Just in this connection I wish to say that want of proper sanitation in harvesting, is a matter that we are too apt to overlook—especially when we consider the class of labor we are compelled to employ.

Who has not seen the evidence of this in the eggplant, exposed for sale in our own home markets; where the print of every finger that touched the fruit in handling, was marked by a decayed spot, due to the perspiration of the ungloved hand of the employes, in harvesting, for home use. It is not possible that the same cause contributes to the breaking down of the citrus fruits in transit? Some of our thin rind fruit may be as susceptible to injury from this cause, as the smooth rind of the eggplant.

One of the principal evils of our present system of packing and shipping is the want of uniformity. This is evidenced in every department of our industry.

It is just as important that we should have a uniform system, as it is necessary for the railroads to have a uniform gage for their tracks. Who does not remember the embarrassment and inconvenience that grew out of the "broad gage," "standard gage" and "narrow gage" of former rival railroads. There must be—above all—a uniform standard of shipping boxes, applicable alike to every State in the union producing the citrus fruits.

[fol. 226] The size of the California box is 11 1-2x11 1-2x26, slats 26 inches by 3 while the size of the box in general use in Florida is 12x12x26 1-2, making a difference of 12 per cent in favor of the California box. This is a dis-

crimination against Florida fruit, and the general public are not educated to note the difference.

To them, a box of oranges, is a box of oranges—without a thought of the fact that one contains more than another. There seems now to be a willingness on the part of our Congress to establish a uniform package for many of the fruits entering into interstate commerce. The influence of every member of this association should be exerted to the utmost, to have the packages for marketing the citrus fruits included in this legislation; and every section engaged in the business should be compelled to use a package of the same cubical contents—or if any section persists in using a package below the standard, they should be marked, "short" when used in interstate commerce.

There should be uniformity in the handling and marketing of fruit, which involves central packing houses in different well defined, sections.

These separate, district, packing houses should at least be under a single advisory head; so as to maintain, as far as possible, uniformity and co-operation in grading for each district.

Perhaps these may be considered Utopian conditions in the present chaotic conditions of the fruit industry in Florida; but, my experience of one year in California, fully convince me that it is imperative—that substantially the same system—as used in California—must, sooner or later, be introduced here.

I venture to predict, in advance of the report of the committee lately returned from that State, that their recommendations will be along this line.

Along the line of shipping early fruit I wish to point out the great harm to our industry by unscrupulous buyers and growers shipping our late varieties under the brand and name of our earliest varieties. This is a palpable fraud [fol. 227] and should, if possible, be regulated by the police powers of the State—making it a misdemeanor for any one to ship the immature and unripe late varieties under the name of the earliest varieties. It is a fact, well known to all growers, that we have early oranges that will go the market in a fairly ripe and palatable condition as early as October, but it is unfair to the consumer, as well as very detrimental to the grower, to have the immature, unripe, and sour fruit of the latest varieties, hastily colored by

artificial means and offered to the Thanksgiving trade as an average sample of Florida oranges. Of course no reputable grower will do so himself, but do not many of our growers who sell their fruit on the trees, know that this will be done?

In the present conditon of orange growing it is, perhaps, unavoidable that we should have oranges of several degrees of excellence—good, bad and indifferent. The uniform influence of this society ought to be earnestly directed to educate the northern jobber to discriminate between the varieties; and the degree of maturity at the different seasons; so that equal quality from any section of the State will command uniform prices. Perhaps, in time, this may be, to some extent regulated by the shippers being compelled to ship the lowest grades of fruit in bulk, as the continued advance of box material will soon make it cheaper to prepare cars for bulk shipment than to pack them in costlier boxes.

In my opinion the shipping of our fruit can be much facilitated, and more advantageously distributed, by selling F. O. B. Fruit will then move only on demand, and the section that can most quickly and cheaply supply the desired quality; will, most likely, get the order. Consignment to unknown markets ought to be discouraged; as fruit so consigned, always comes in direct competition with purchased fruit; to the injury of bona fide buyers. It is quite certain that the great majority of responsible solicitors would prefer to become F. O. B. buyers, if selling were more general, [fol. 228] and the grades made perfectly reliable. In time all the best grades would be sold at the packing house, and only the inferior grades—from poor handling—would go forward on consignment.

In conclusion, I want to urge the importance of neatness and scrupulous sanitation in every department. Clean hands, clean picking boxes; bright, well seasoned packing boxes—clean, sanitary cars for carrying the fruit to market—for it is a commercial fact, that if you please the eye you touch the pocket book.

"So mote it be."

By S. C. Warner

Mr. President, Ladies and Gentlemen: At the last meeting of this society we had reports from your commit-

tee on the subject before us that were extremely valuable and I can add but little to their suggestions. Permit me, however, to quote from a recent article by one who is an authority:

"Harvesting—This is one of the most absorbing subjects of the day and demands the most thorough and careful investigation and thought, followed by the most energetic action upon the part of every one engaged in the fruit industry. Our careless handling is costing the state thousands, yea, hundreds of thousands of dollars every year. I make the assertion that fully 90 per cent of the Florida fruit that arrives in market in bad order is attributed to careless clipping and careless handling.

"All of us flatter ourselves that we are taking extra pains and doing better than our neighbors and if our fruit does not reach its destination sound the fault lies with the transportation companies and not with us; when, if the truth were known fully one-fourth of our oranges were either punctured by the clippers, scratched by the fingernails or bruised by dropping, jamming against ladders, pouring into field boxes, the rough treatment by teamsters and emptying and piling into hoppers and falling from the sizers into the bins." This from Dr. Inman.

[fol. 229] It is an inconsistency not easily explained why we expend so much labor and money in the production of a crop which receives such meagre attention in its preparation for market as do our citrus fruits.

We have, no doubt, sometimes questioned the inherent quality of our oranges to "stand up" but are not the causes of decay—at least in great measure—our own lack of careful, intelligent, systematic work.

Weather conditions, when fruit is picked, must be right. This, I regard as one of the important factors in successful shipping. Oranges should not be picked when the fruit hanging on the trees shows decay to any considerable extent, even when split or thorned. It is apt to be very inconvenient to lay off the hands at such a time but if the work is persisted in the results are pretty sure to be very unsatisfactory. Simple wetness, as from dew, is not important but if the degree of humidity is such that the decay of the fruit on the trees is very noticeable, decay of the packed fruit, even where care is otherwise used, is apt to result.

The Somer-Hart clippers I like better than any others that I have used. They cut a clean, short stem and with ordinary care, clipper-cutting and scratching is avoided.

As a receptacle for the picked fruit the sack should be avoided. The basket or can, with a perfectly smooth surface inside is very much safer, avoiding the pressure of the body of the workman, thorning and bruising.

The grove box should be carefully made, every edge which can come into contact with the fruit being rounded and sandpapered. Its capacity should not much exceed three pecks, and the top slat being two inches below the top of the end, which we make in panel. The willow splint baskets, used by grocers, make a very desirable field crate, affording excellent ventilation and being light to handle.

In delivering the fruit to the washer or brushing machine it should not be piled more than two deep in the hopper—[fol. 230] better only one layer. In emptying the field crate a canvas cover should be drawn over the top, one edge being fastened to the bottom of the hopper, and the fruit can then be poured out without bumping and bruising.

Cleaning fruit adds to its attractiveness and quite possibly to its keeping quality, if done with proper care. There must be no abrasion of the skin nor rupturing of the cells from pressure. This, of course, would be fatal.

Sorting is one of the most important packing house operations and should have the greatest care. Cull fruit should never pass the sorter. It would be extremely desirable if the different grades could be so standardized that it would not be a matter of mere whim or individual opinion as to what constitutes a "fancy" "choice bright" and so on. This will perhaps be one of the benefits of the new marketing system which I devoutly hope will materialize.

As the fruit comes into the packing-house, after it has been cleaned and sorted, it is desirable to have room for storage before sizing. If boxes are used they should be so made and used as to give the best possible ventilation to their contents. Rack bins are, however, better. In them the fruit receives unobstructed exposure to the air, the pores are more quickly closed and possible scratches have a better opportunity of drying and healing over. A few hours of this treatment should place the fruit in good condition for packing.

One of our most successful growers dispenses with packing-house curing entirely by letting the fruit remain out in the grove, after picking, for about twenty-four hours before hauling to the packing-house. If the results of a method are a measure of its success, this is certainly a good one.

With the excellent machines now in use there should be no trouble in sizing properly. I use the latest Maull production and find it quite satisfactory for oranges, grapefruit and tangerines.

[fol. 231] Whether the "bulge" or flat pack be adopted the box should contain all the oranges possible without bruising. There is scant excuse for a slack packed box.

I use a press, also made by Maull. Some sort of press, I deem very important as the jar to the fruit in nailing down the cover should be avoided.

Whether white or manila paper be used or whether there be trimming is, perhaps, not very important but it is pretty sure to be a matter of satisfaction and profit to make the package as attractive as possible. It should be a matter of pride with us, as it is with the California packers.

Stenciling and stamping should be neat and in good taste and it is well to use some distinctive motto or brand, unless we want our work for our own sufficient reasons, to be anonymous.

Let me add a few "don'ts."

Don't pick your fruit when you notice split fruit decaying rapidly on the trees.

Don't use a grove crate holding more than three pecks.

Don't permit a long or pointed stem on your fruit.

Don't fill your grove crate so that the highest orange will touch the bottom of the crate above when stacked.

Don't pick into a sack.

Don't pour your fruit so that it will fall more than one inch unless it strikes a cushion.

Don't permit a sharp point or edge in crate or bin where it can come into contact with the fruit.

Don't permit long fingernails to be worn by pickers or packing-house men.

Don't permit jolting when the fruit is being hauled.

With regard to artificial means of preventing decay, fumigation in the car has not been found to give good results. In some cases a spray or bath of ammoniacal solution of copper carbonate or bisulphate of soda has been efficient.

There is one point that we cannot too much emphasize, the value of reputation; not only our individual reputation [fol. 232] but the reputation of the Florida fruit generally. You are aware how sensitive the market is, how quickly there is depression when fruit is arriving in bad order, how quickly buyers turn to some other source of supply.

We are all, to a considerable extent, dependent on each other for the popularity of our fruit, and in this connection there is one question I would ask you to consider: Whether the reputation of Florida citrus fruits has not suffered from the practice of selling on the tree, leaving the picking and packing as well as marketing to parties who have an interest only in the selling of that particular crop and not in the reputation of the fruit in a general way and which is dependent on careful selection as to maturity and proper handling generally. Is not the manner in which much of our fruit handled by buyers seriously detrimental to us? Having no further interest than getting results from that one crop, depending on the incident of good weather to delay decay which will ultimately result from careless handling, perhaps deferring it till the fruit has gone into the hands of the retailer, who suffers in consequence and then makes us suffer later.

Is it not a fact that this practice has a very far reaching effect on the reputation and popularity of our citrus fruits?

Report from Committee Visiting California

By W. S. Hart

MR. PRESIDENT, LADIES AND GENTLEMEN: I am a little afraid that our members present may be disappointed in the value of my report of the visit to California, for the reason that I did not know until this morning that a report was expected. If the convention had been held a week or ten days later so that more of the members of that commit- [fol. 233] tee could have been present, then we might have had a very important and valuable report, I am sure. Since my return I have not really had time to give a thought to the matter much less to get our experiences and impressions up in a systematic form. If I miss any points, just fire the questions at me and I will do my best to answer them.

In the beginning let me say that this party started out, not for a pleasure expedition, but for business. It is true that we had every courtesy shown us, every comfort that modern convenience could supply in the way of pullman cars, diners, observation car and a club car; three cars being devoted to our exclusive use, and on the way back there was as much of this as we needed, though part of our party was left on the way. We stopped at the Grand Canyon on our way out and the Pullmans were kept there for us. As we went to Los Angeles the next day and while still in the desert a committee came out to meet us from San Bernardino, bringing flowers and fruits and in that party were fruit growers, bankers and others who could answer intelligently almost any question we might ask of them.

When we got to Los Angeles, the Chamber of Commerce gave us the Directors' room in which to hold our meetings, which was most excellent for that purpose. The California Fruit Exchange invited us to be present at their business meetings so that we might see the inside workings of their system and they showed us their books and gave us every opportunity possible to study the marketing system of California which is, no doubt, the best in this country. If their method of handling fruit can be adapted to our state of at least a large portion of the shippers, as I am sure it can be, it will mean a saving of hundreds of thousands of dollars every year.

Leaving our baggage at Los Angeles, Messrs. Powell and Burton conducted our party to Corina, Azusa, Pomona, San Dirnas, Riverside, Redlands, San Bernardino and other places and for two days we were taken through the groves, [fol. 234] through the packing houses and through the most beautiful spots of one of the most beautiful countries in the world. We were given every opportunity of studying their system of packing and handling fruit. At Riverside we were taken to the top of quite a high mountain, standing alone in the valley, where we could look down upon twenty-five to thirty thousand acres of thrifty orange groves with the San Bernardino range of snow-clad mountains to shelter them and form a noble background for this beautiful picture.

Leaving Los Angeles, we continued on to San Francisco, then to Chicago where we were taken all over the city in an automobile, through the wholesale fruit districts, etc., then home.

I hardly know where to commence; there is so much material I can only give you a little smattering.

The president suggests that I give you an idea of the size of the groves, trees, etc. I will say that the trees, many of them, are not large; perhaps they may average something like ours, but I was taken through one grove, Mr. Powell's grove, at Azusa, where the record returns for California were made. In one crop they made $5,000 off two acres. These trees were large and being budded at Valencia late, the fruit comes to market in the summer and fall and meets no competition. Further north, in Tulare County, large areas are being planted and a great many young groves are coming on. They tell me they are planting very heavily around that point. I am told that the fruit raised is of a much finer quality, being more like a Florida orange. I saw some of them at San Francisco, that were really very good fruit.

Some of the California handling and packing system can be adopted and applied by the large growers here in this state, but I want to tell you that the California orange will stand treatment that would put a Florida orange out of business. Take for instance, just the mere method of putting on the covers. They fill their boxes full of oranges level to the top, then they put on another layer. It is then put [fol. 235] under the press and the cover brought down and nailed. Suppose we tried that with our fruit. The person who did so would be soaking wet in five minutes from the juice flying from the oranges. Yet Mr. Powell who has done so much to improve the methods in California, told me that the top layer did not show decay as much as the middle.

A great many of the packers and shippers think they are handling fruit very carefully and they are taking a great deal of pains to do so, but there are those in Florida who can discount them in the handling and grading of oranges. They really don't know what really careful handling and packing is. Perhaps they do not need to, however, as their fruit will stand much rougher handling than ours. They have been held up to us as models and justly so in many ways and they have many methods that we might follow to our advantage, but they may also learn much from a careful study of Florida methods and practices.

Some of the packing houses are operated by the independents, and some, the greater number, of course, are under the fruit exchange management. There are a great many different methods, but in a general way they resemble each other. In some, the fruit is first washed or brushed and then it goes onto the belts that carry it along to be graded. After grading it goes into the long sizers, thirty-two feet long, most of them. In some of the houses they use an electric sizer where the oranges are carried along on a belt until a certain size will trip a certain finger which causes it to be kicked off the belt into the packing bins. The fruit of California is all sized by the smallest diameter. Our fruit needs to be sized by the largest. Therefore, we have to have a different system of sizing than they have there. They have a box-making and nailing machine that will nail from 1,200 to 2,400 boxes a day. The machine turns them off very rapidly. One man to attend the machine can turn out 1,200 complete boxes or more; two men about 2,400 boxes a day. Their boxes are made with two pieces on each side and this machine turns them off complete. They use a [fol. 236] fancy label that they paste on the head of the box as you probably all know. Quite a number of packers of the state told me that they wish that they had never been adopted, but still they look very pretty and they have a very great variety of designs.

Instead of grading by number, they grade by brand and have a different brand for each quality as put up. There is one packing house at Riverside that now stamps a little tag right onto the orange. When you unwrap the orange, there is a little elephant that stays right with the orange until it is eaten. The orange never loses its identity. Pre-cooling before shipping is being carefully tested there with very satisfactory results. The marketing system was explained at our last meeting. I will not attempt to give you that now, because I think most of you have had it through what Dr. Inman has said.

Question. How far apart are the trees planted in the old groves and the new ones, and about what is the average crop?

Mr. Hart: Well, the trees are planted at various distances as in this state and I think they will average about the same distance apart as on our hammock lands. I don't think many of them are as far apart as in some groves on

the pine land here. Those very large trees I spoke of covered only two acres and were much larger than any others I saw. I don't know what their yield was in boxes but four, five and six boxes to the tree seems to be about the average judging from what we could learn there.

Question. Tell us about the cleaning system.

Mr. Hart: Most of the oranges are washed or brushed, although some are not. Where the fruit is clean and they can avoid it, many neither wash or brush it, while in other groves, all the fruit is washed. Some of it is run through a solution of permanganate of potash to kill all germs, but Mr. Powell told me that no chemical could be used that would kill the spores of blue mould.

[fol. 237] Dr. Richardson: Is that used in such strength as to color the orange any? It is one of the active discolorants of water and possibly it may color the fruit.

Mr. Hart: No, I don't think you can discover any effect of that kind on the orange.

Dr. Richardson: It is used for the purpose of destroying germs, possibly. It is one of the best germicides known.

Mr. Gillette: How does the quality of their Tardiff orange compare with ours?

Mr. Hart: It is a thicker skinned fruit, and a darker red, but is not as heavy a fruit and I think will average smaller.

Mr. Dade: Do they have rusty oranges there?

Mr. Hart: No, I don't think they have the rust mite there. I talked with the horticultural commissioner about it and they thought they had, but the specimens they showed me did not show the effect of the rust mite. I think it must be something else. They have had a little touch of the whitefly but are confident that they have wiped it out. The commissioner told me he would give me $5.00 to find a whitefly. They exterminated it with fumigation; that is, they covered the trees with tents and treat them with gas. In California, that is a very much more simple matter than in Florida. Where there is irrigation they can raise almost anything—orange trees, pepper trees, eucalyptus and roses galore; oh, such roses:—flowers of all kinds, but just outside the line of irrigation there is nothing but sage brush or scrub; no timber at all, while in this country we have plants and trees that are host plants for the fly, scattered all over everywhere. Now if they can clean up a grove out there, the whitefly does not come in from outside. It is true

orange groves there are all in one great body generally, but if they gas their trees and do it universally—and they have laws there which make it compulsory—I don't see why they cannot just about exterminate him. With us it is entirely different and a far more difficult proposition. We have got a state full of china berry trees and all other [fol. 238] kind of trees that harbor the whitefly about as well as the orange trees and when we fumigate or spray to kill the ones that are in the grove, the ones from the outside sit around and wait until we have finished and then come right in and live with us.

Their worst enemy seems to be the black scale, which is confined largely to the coast. The purple scale, which with us is a minor trouble, seems to trouble them a great deal. They have a gum disease among them. The gum will ooze from the limb or the trunk. They tell me the disease commences from the inside of the trunk and in a little while the limb or trunk is dead. They have no treatment that they claim to be a positive cure but several things are recommended for it. It very much resembles the foot rot on our trees only that it appears higher up in the tree. The best remedy they have found is to dig out the dirt and expose the roots. Some apply one or another application to it, but I think that the most satisfactory remedy that they use is to just dig under the trees and expose the roots.

Question: I would like to hear about the labor they have in picking and packing fruit. How does it compare in intelligence and availability with ours and what do they have to pay for it.

Mr. Hart: They use white help mostly. The greater portion of their fruit is packed by white men and women. In some packing-houses they use the Chinese and I think they are found quite satisfactory help, too. They seem faithful and a number of growers to whom I talked seemed to think them very good help. There are not many Japanese employed and as a rule they are not liked as well as the Chinese.

Question: Did you see any paraffining process?

Mr. Hart: I did not. They have another trouble that looked to me very much like blight but when I asked about this tree or that tree that was suffering from it, they told me it was caused by gophers. Mr. Chase, who is one of the

largest growers in California, told me it cost him $1,000.00 a year to fight gophers.

[fol. 239] Question. Why is it necessary to put the extra layer of oranges on top as you spoke of a few minutes ago?

Mr. Hart: It is to make a full box. They claim that unless they pack very full the fruit gets into the market loose. In going through the fruit districts in Chicago, I noticed the fruit coming from California showed full boxes.

Mr. ——: Did they nail down the head at the center?

Mr. Hart: No, only at the two ends.

Mr. ——: Mr. Chase has been introducing a bulge pack similar to the California pack. His man at Sanford started it first at Sanford. You know the pack I mean, do you not?

Mr. Tabor: Did you find out what stock those trees were budded on, the ones that showed the gum disease more prevalent?

Mr. Hart: I do not think that the stock, so far as I could tell makes much difference because the disease is up above the bud or in the limb, so that so far as I could learn the stock made very little difference.

Mr. Stevens: Have they a choice of stock?

Mr. Hart: They are getting seeds of sour oranges from this country and prefer the sour stock.

Mr. Tabor: Is it true in Florida and in Cuba that trees budded on lemon stock show gum disease much more than sour?

Mr. Hart: I am not an authority on that. I have not had enough to do with the rough lemon stock to know of my own knowledge, but I have had experience enough to make me dislike it, and I do not think I shall ever put any more in my grove.

Mr. Quinby is present, and undoubtedly he can answer a lot of questions that I cannot, and I think you had better ask him to talk a little.

Mr. Gaitskill: Just a moment. Tell us before you go what they have out there in the line you have been talking about that is better than what we have that could be adopted here.

[fol. 240] Mr. Hart: I think the belt system of carrying the fruit along for grading will be adopted by a good many of the larger growers. It would not do where extreme care is taken, because the fruit is going along pretty rapidly, and if they miss a No. 2 or 3, it goes into the No. 1 fruit. I

do not think their nailing machine would answer for our boxes, because we strap ours while they only nail a little piece across each end of the cover, which is done when the cover is put on. They have a little device for holding the paper wrappers which they all use. It simply holds the paper in the tray when you are packing and keeps it from blowing about. They also use a "nail stripper", that is a help. There are small devices like that, some of which I have adopted and some I cannot. I am not the one to pass on the general packing-house outfit for the larger growers of the State, being only a small grower and requiring a totally different arrangement.

Mr. Gaitskill: I have found your suggestions good and anything that is good for you will be good for me.

Mr. Hart: There is an orange clipper that they use in California, and here is a new one just gotten out which I will leave on the desk for you to examine.

Mr. Quinby: I went with the California party and gathered in a good deal of information while out there, and a lot of it would be interesting and doubtless instructive to this audience. My voice is not at its best, but possibly it will improve the carrying quality of the Florida orange.

I am connected with the firm of Chase & Co., of Jacksonville, who market considerable of the Florida oranges and other perishable products. We examined pretty thoroughly into their marketing system while in California; in fact we went into the intricacies of it and there has been a time set on the 1st of June at Tampa to bring in reports.

When we arrived at Los Angeles, Dr. Inman called a meeting at the Chamber of Commerce, and we undertook to [fol. 241] systematize the work for which we had gone there. The subject matter was divided into headings, such as packing houses and their appliances, selling, government investigations, and a number of various heads that we wanted to know about, and committees were appointed to take up specially the matter on which they were to be prepared to make reports to the meeting at Tampa on the 1st of June. I was on one or two of these committees, and while I took copious notes I have not looked over them at all since I came back, and I don't know that I can say anything in addition to what Hr. Hart has said, except to answer such questions as you may ask to the best of my ability. I would

not undertake to go into full and complete relation of what we saw and heard and learned while in California.

It seems to have been the expectation of this meeting to have more or less reports from the committee who went to California in a formal way. It was suggested to me that if we passed a resolution to incorporate into the report of the Society the reports and results of the meeting which is to be held in Tampa next month, then it would be in print for the members of this Association and they would have the benefit of it in this way. I do not know your regular custom, but think it would be a good idea to pass a resolution now that the Secretary shall incorporate into the official report of the Florida State Horticultural Society the report that is made in Tampa on the 1st of June, and then you will have that report in full.

Mr. Temple: Do you know how much their oranges cost them per box on the trees out there as a general thing?

Mr. Quinby: No, I do not know; that is, interest on investment, working, fertilizing, etc. I should say it is just about the same as in Florida for the reason that they cultivate a great deal more and they spend a great deal more money on irrigation than we do here, but they are almost free from having to use fertilizer. That is almost unknown in California. Their oranges are grown on what I have [fol. 242] known as clay soil. It has more or less of crushed granite and that keeps it loose. They do not let anything grow on it except the orange trees themselves, and cultivate all the year round.

Mr. Temple: Do you know what they receive as a general thing for their oranges on the trees?

Mr. Quinby: They get about 90 cents or $1.00 a box on the trees. This is clear of the packing-house charge and the marketing expense.

Mr. ——: What variety do they grow principally out there?

Mr. Quinby: We saw very few oranges except the Washington Navels. There are a good many Valencias, but I think about 80 per cent. of the output of California is Washington Navels. Now what they are putting out in Tulare County, which is about 300 miles north of Los Angeles, I don't know. They are planting very heavily there, however.

Mr. ——: How does the price of box material compare with ours?

Mr. Quinby: It is cheaper than ours. They buy it by the wholesale. They have their own mills. They have cut loose from a lumber trust out there and have backed up certain independent mills that were about to go broke, and in that way have kept the mills running and have been able thereby to take about all the output of these mills. Their package is not as good material as ours; it would not do with us for shipments in less than carload lots. The bottoms and sides are slats, and the ends are solid.

Mr. ——: Is there much setting out of new varieties?

Mr. Quinby: In Southern California proper, that is, those valleys lying around Los Angeles, there is a fair amount of setting out, probably just as much as in Florida today. In Tulare County there are a great many new groves being set out. I am not prepared to tell you whether they are planting in the new groves a larger number of Valencias than the Nashington Navels or not.

[fol. 243] As to the production of oranges, unless there are disasters to the groves, or crop disasters in the next six or seven years, the output of oranges will be almost overwhelming. We were told that there were 20,000 acres of new grove property coming on in Tulare County alone. They are putting out groves in Arizona and Texas, and the increase in the Florida output in the next seven or eight years will be enormous. This fact is rather significant if you stop to think about it. Of course we don't know what disaster may happen to reduce that output.

Mr. Christiancy: I understand the water supply is playing out on a number of large dams in Southern California. I spent 15 or 18 years in California, and know of two large dams that went dry at one time, and they were a couple of years in getting water.

Mr. Quinby: We did not look into the water supply. We know that the water is sold, and in some sections the water contracts are appurtenant to the lands.

Mr. ——: Tell us the methods they use for getting their fruit into the market?

Mr. Quinby: That is a wide question, and the meat in the cocoanut. To handle a Washington Navel orange, considering the geographic position that California occupies in

relation to its consuming markets, I don't know of any set of men who could improve on their system unless they were all Solomons. Their system is something that has evolved itself. It is not the work of any one man or set of men. It is the result of experiments and the natural evolvement to fit the conditions of California. The method is this; last year the exact figures that the California Exchange handled in oranges was 5,440,000 and some odd boxes that represented 56 per cent. of the total California output as near as they could get complete record, and that would throw the crop between 9,000,000 and 10,000,000 boxes. The estimate for this year is for a crop of 12,000,000 boxes of oranges and they estimate that the Exchange will market 55 to 60 per cent. The officials of the Exchange do not claim that their control will reach beyond 60 per cent., and Mr. [fol. 244] Story, who is President of the Exchange, told me it was not wise for them to undertake to market more than this. He said that in order to make a success of this thing there must be competitive selling, not competitive underselling, but competition to return a better price to the grower all the time. Competitive underselling, which means a cutting of prices, must be stopped. California has arrived at such a point that they are in condition to stop under quoting, and the Exchange desires to market no more than 60 per cent. of the crop, so that conditions may remain as they are today. Now the 40 to 45 per cent. of fruit that is sold by the independents is marketed both by salaried associations and also agencies working by per box contract, and in some instances are affiliated with the Exchange; and most of it is marketed on f. o. b. or in transit basis or else a spot cash basis. This means that if a buyer is putting his money into the fruit, that fruit is going where there is a demand. Under the system of cash buying and f. o. b. and in transit buying, that much of the goods takes care of itself, because it is going where there is a demand. Now the 60 per cent. is the balance of the product, and it is up to the California Fruit Growers' Exchange to take it and develop it into a paying proposition. Their number of f. o. b. and in transit sales are almost minimum. They have abandoned the f. o. b. and in transit sales almost entirely. They have the markets of this country extremely well gauged

and they can sit in their offices and tell you just how many each market should take, and how it will make the market waver if you give them any more, and how it will make the price come up if you give them a little less.

Suppose the fruit goes to Kansas City and the market is a little off. The buying trade is told the price is so-and-so. They look at the fruit and take it or reject it. If it is refused the man in charge of the selling end in Kansas City wires in to Los Angeles that the trade will not take it at the price he offered it to them. Then they may tell him to sell so many cars at the price he is offered and divert the other [fol. 245] cars. Possibly they may divert the whole lot. They carry their goods all over the country, and the Washington Navel will stand it. There is no additional cost for freight. In other words, after the cars once get to Denver it costs no more to send a car to Boston than to Kansas City. In that way they distribute vast amounts of oranges, and at this present time it is a fact that they have every known market just about crowded without having to make concessions on the price. They have studied this marketing question for years from every possible standpoint. It is a wonderful thing to sit in their office out in Los Angeles and see how they know the exact condition of every market, how they can put their finger on every car that is between California and the Atlantic Ocean, gauge almost to a carload what this market will take without the price being lowered, and taking away a little here where there is too much, to hurry it across several states perhaps, where there is not guite enough.

The Board of Directors are representative business men from every orange growing section in California.

Now, these people out there know that the quantity of oranges going into the markets is getting to be enormous. They know that in the next six or seven years the present output will be greatly increased; therefore their far-sightedness is such that they are already beginning to work on the consumer. They have commenced newspaper and magazine advertising that will bring the matter right before plain John Smith and his wife, so that it will create a desire in them to have oranges on their tables. They took the State of Iowa and put aside $— for advertising. They

don't work on the jobbing trade nor on the retailer. They went right to work on the consumer, and are making him desire it, and they have increased the consumption in the State of Iowa about 50 per cent. the first year. They have appropriated money out of the common fund to increase the consumption in that way. These people are right up-[fol. 246] to-date—in this instance you might say they are ahead of time, and they know what judicious advertising does.

It is going to take lots of time and long-continued efforts to bring order out of the chaos into which the Florida orange growers have fallen; perhaps it is not so much chaotic as lethargic. We have needed an awakening for some time; last winter's prices showed how much. It is going to mean spending money; it is going to mean co-operation but for every cent that is spent I believe you will get a dollar in return. Above all things it means co-operation, one and all.

Out there they do business by encouraging the small buyer just as much as any other; they give him just as good prices on a one-car lot as on several; they give him just as much advantage of market conditions and just as good grades and brands for the money as they give the twenty or fifty car man, because the small buyer is always ready to do business for a little less than the big one. Now about selling direct to the consumer, I have heard Mr. Chase talk about this. I think there is but one way to do this, and that is to go into the store business in every city. That would mean a good deal, and I don't think we are prepared to follow. The thing is to try to introduce the general use of the fruit into the small communities. Because a small dealer is poor is no reason why we should try to keep him poor.

The independents use the auction to some extent. This is the final court of reckoning for all the California product. They may have peddled it across the country and finally wound up there. They never sell privately in any market, that is, the Exchange does not where there is an auction. In those markets where there is a fruit auction they do not sell outside.

Mr. Christiancy: Can you tell us how long it has been in this systematized condition?

Mr. Quinby: In 1892 they were just as disorganized as we are today and for ten years they had a terrible time and a terrible struggle. In 1903 they began what was [fol. 247] known as the Fruit Agency, a joint office of the Independents and the Southern California Fruit Exchange as it was then called. This Agency ran from the 1st of April, 1903, until the 31st of August, 1904, and was a consolidation of all agencies into one selling office. There was only one office from which you could buy fruit. The fruit carried badly that year. They abandoned the Agency and now let the Independents compete with the Exchange, so that the grower has two strings to his bow, and a good many take advantage of it. Until after the season of 1902-3 under the regime of the Southern California Fruit Exchange, was a hard time for California growers. There were individual interests fighting the Exchange, marketing interests fighting it that were tied up with car lines, and corporations fighting it. From 1892 to 1903 they were not making much of a success of it because they were fighting each other. They fought so hard that they agreed to stop fighting. Now with the California Fruit Growers' Exchange handling 55 to 60 per cent. and the Independents the balance, they have things in pretty good working shape, and it would be well for us to follow it as nearly as we can, adapting it of course, to suit our different conditions.

Mr. Christiancy: I have been told that on all fruit that goes out of Riverside the grower is paid the same price per box; that is, every man gets the same per box for his fruit whether he sent 39 or 3,900 boxes.

Mr. Quinby: That is true in California except those growers who put up their own fruit. The grower does not know anything about the price per box. His fruit is weighed in at the packing-house and of course, he knows how much his fruit weighs. Then it practically loses its identity. It is graded and then it goes on the sizer belt. His fruit is entered upon the books of the association by its weight and the distribution of returns is made according to weight. He does not know how many boxes he has, and it would take a Philadelphia lawyer to figure out what his [fol. 248] fruit has brought him per box. His fruit loses its identity and individuality entirely after it is weighed.

Mr. Christiancy: The officials of the Exchange then could spend a half million dollars of the money and the growers would not know it.

Mr. Quinby: I must say that I don't think there is any grafting going on in the Exchange. One or two are said to have been made millionaires in the past, but I don't think there is any of that now. I think they are holding back 10 cents a box now to create a fund for advertising purposes and other things possibly. Their fruit is sold on the box basis and the returns come on that basis to the local associations. There it is split up into pounds. The records on the books are generally in pounds and so are the credit to the individual growers. The distribution is made in that way.

Discussion

Mr. Penny: I make a motion that the California committee be requested to furnish a report to our Secretary so that it may be published in the proceedings of the Society.

Dr. Richardson: You have heard the motion which is to the effect that the Secretary of the Society be instructed to ask the Orange Growers' Society for copy of the report of the California Committee with the idea of copying it, or such portions of it as the Secretary and Executive Committee may deem wise, in our printed journal. I presume that is the way you wish the motion put, Mr. Penny?

Motion seconded and passed.

Mr. Hart: I want to bring up the matter of this trip to California before we go on to the next topic. On this trip, the greatest benefit I received was contact with the men who made up the party. They are men who are successful in the line of work they followed. Now, I want to urge upon the members of this Association the importance of their going to Tampa to attend that meeting there. It seems to me that the psychic moment for organization has arrived. Of course organization will not make returns of $2 or $3 [fol. 249] a box for poorly packed and poorly grown oranges, yet where fruit is properly handled the grower will get better returns for his money invested, his work and trouble in growing the fruit and will not feel that orange

growing is so much a venture but more of a legitimate business. I hope that every orange grower, in fact, everyone interested in Florida and her future prosperity will attend the meeting and help in the work, and I think it will be a mistake if the orange growers especially, do not do so.

Dr. Richardson: I most heartily agree with Mr. Hart. I feel strongly every word said in my address last night. I feel that the time is upon us now when we should demand and get our rights. This paper that has been read is of vast importance. It shows us what a small body of men, comparatively speaking, have been able to do with the railroad situation, and this small body of men have prevailed upon the State Commerce Commission to save us a great many thousand dollars. If we all combined, what might we not accomplish? Our savings would mount up into the millions in a short time.

This Orange Growers' Association is, as I understand it, still in an embryonic state. There was a meeting called in Tampa some two or three months ago for the purpose of organization. The organization was not completed at that time. We decided that a committee should go to California and spy out the land and come back and report on the 1st of June to another meeting at which all orange growers and all men interested in horticultural and agricultural matters could come and be welcome. We hope you will all come: as a citizen of Tampa I invite you and as a member of this Society and as its President I urge upon you to come to that meeting. It did me good to go to the preliminary meeting. Mr. Hart says it did him good to be associated with men of their calibre, and I am sure Mr. Hart will permit me to say that it did them good to be associated with [fol. 250] Mr. Hart. No thanks are necessary sir, I am sure there are no growers in the State who could not learn many things from you.

You must wake up to the importance of organization. We have to do it some time, and why not now? Why wait another year and get returns that will barely pay the running expenses; perhaps not that. These men in California are reaping a rich harvest as a result of their organization. We must take some decided action if we expect to get anything in the way of returns.

I feel that it is incumbent upon the Chair to reinforce Mr. Hart's and Mr. Quinby's remarks. Get your local papers, if you can, to call attention to it and let it be the beginning of organization that will give Florida her rights which she has been denied so long. Who is to blame for it? Who is responsible for the conditions that are existing today, where we, who grow the best oranges on earth, can hardly make the expenses necessary to grow them? You have no one but yourself to blame. In your strenuous opposition to each other you have forgotten that it is only in union that there is strength. Fighting each other, you are like the Kilkenny cats; in joining forces you may assume proportions that will win you the victory over all opposition. Don't let this matter fill you with enthusiasm for the time being, and then be forgotten. Join forces with the most influential men, the brainiest men, the most successful men and help them to make this thing a success. You have everything to gain and nothing to lose.

Dr. Richardson: I have been testing these clippers. I don't know what Mr. Hart intended to do for the people of California in bringing these as samples but have been testing them on some rose stems here on the desk. The clippers from California do not cut rose stems every time, while Mr. Hart's clipper cuts them every time.

[fol. 251] PLAINTIFFS' EXHIBIT NO. 14

Proceedings of the Twenty-third Annual Meeting of the Florida State Horticultural Society, Held at Orlando May 17, 18, 19, and 20, 1910

Compiled by the Secretary, Published by the Society

Causes of Decay of Florida Oranges in Transit to Market

A Review of the Work of the U. S. Department of Agriculture in Florida, 1907-1910

A. V. Stubenrauch, in Charge of Fruit Transportation and Storage Investigations, U. S. Department of Agriculture

MR. PRESIDENT, LADIES AND GENTLEMEN: I regret that my former associate, Mr. Lloyd S. Tenny, is not able to attend this meeting and give an account of the investigations of

the causes of decay of oranges in transit from Florida. Mr. Tenny had charge of this work since it was started four years ago, and is fully conversant with every part of it. He it was who planned the experiments and demonstrations and it is largely due to his efforts that the work owes its progress. I am not as familiar with the work of the Bureau of Plant Industry in Florida as was Mr. Tenny. I have therefore to rely upon the data and information accumulated by others, and this paper, then, will have to be mostly in the nature of a review of what has been done and an account of what is planned for the future.

[fol. 252] The citrus transportation investigations of the Bureau of Plant Industry were begun seven years ago in California. For some time prior to that time the orange growers of California urged the bureau to begin an investigation of the causes of the decay of their fruit in transit. It was estimated that an average of 5 per cent. of the entire crop shipped out decayed en route, thus entailing an enormous loss to the growers. The progress and results of these California investigations are perhaps familiar to most of the members of the Florida Society. The work was published as Bulletin No. 123 of the Bureau of Plant Industry.

The success of the California investigations led to requests for a similar line of work in Florida. In response to these requests Mr. Tenny was delegated to carry out the investigations in the Florida citrus districts and he and a number of associates have been at work and have given accounts of the progress of the work in papers read before the annual meetings of this society.

The ultimate aim of fruit growing is profit—to sell the crop at a profit. It follows that any investigations which have for their object the improvement of the crop must also have the dollars-and-cents end in view. The utilitarian object cannot be neglected and the improvements which may follow the investigations must be made profitable to the growers. We have endeavored in the work which has been done never to lose sight of this fact.

It is useless to raise a crop of fruit, no matter how fine it may be, unless it can be marketed or sold at a profit. This selling or marketing end of the fruit industry is a

special business of itself, requiring special talents and training. Especially is this true in an industry like the citrus fruit industry which has now reached such large proportions that the marketing problems are becoming more complex every day. Fruit growers are recognizing this fact and now employ specially trained and competent managers and salesmen to attend to the selling end of the business.

[fol. 253] The basis of all successful marketing of fruit products is good fruit put up in attractive shape and gotten to market in sound condition. The problems of handling a fruit crop of the extent of the citrus crop are problems of wide distribution, the solution of which depends largely upon the possibility of getting the product to market in sound condition.

The fruit growers have mastered many of the problems of production. These have to deal with the various orchard practices of planting, cultivating, fertilizing, pruning, control of insect pests and fungus diseases. Most attention has been directed toward these factors in the past. But it has frequently happened that growers who do their utmost to produce fine fruit, and who succeed in producing fine fruit, nullify all these efforts by the way in which they prepare their product for market. It has not uncommonly happened that the bureau workers have observed fine fruit which the growers have spared no expense to produce, utterly ruined in its preparation for shipment, as a result of the attempt to save a few cents per box in the cost of handling it. In a general way, most fruit growers realize that fruit must be handled carefully. But few realize what careful handling really means, and still fewer appreciate or realize the amount of injury which is actually due to careless methods of handling.

Decay affects the grower in two ways:

First: Decay is a direct loss to the buyer of the fruit and is always charged to the grower. He always has to pay for it.

Second: Decay affects the market reputation of the grower's pack.

The first loss is relatively easy to calculate. It is estimated that the loss to the California growers was from 1 to 1 1-2 millions of dollars annually. The loss to the Flor-

ida growers has equaled a half or three-quarters of a million annually.

The second loss is perhaps the most important, but cannot be easily estimated.

[fol. 254] The actual money value of the reputation of brands arriving consistently sound and in good, attractive condition cannot be stated. It means not only a premium above ordinary market prices, but a more ready sale and active demand. In times of low market conditions such brands will find sale at fair profit while those with poor reputations can hardly be given away.

At one time it was thought that a certain percentage of decay was inevitable and unavoidable. And this is true; but to a much more limited extent than was formerly recognized. Buyers take these losses into account in paying the producer for his crop, and they also take decay into account when they retail the fruit to the consumer.

The producer is affected both ways. He not only receives less for his product, but the demand is decreased and fewer people can afford to buy. Buyers can naturally pay more for sound fruit which will hold up in the market, and they do not have to charge so great a margin of profit to the consumer.

The bureau investigations were undertaken to determine the causes of decay and to make a study of the relation of handling the fruit for market to the occurrence of decay, if there is such a relation.

The cause of most of the decay is the growth of the blue mold fungus, one of the commonest forms of mold or decay. A thorough study of the behavior of the fungus on citrus fruits was made both in the laboratory and in the packing houses. What is here stated may be familiar to almost everybody present, but the point is so important that it is well worthy of repetition.

Blue mold is not a true parasite, i. e., it does not live on healthy living tissue. It lives and grows on dead tissue just as the higher plants live in the soil and draw their nourishment from it. The fungus must have dead tissue on which to start. It must have moisture and warmth. It has not the power to penetrate the sound healthy skin of fruits. The fruit as it leaves the tree is a living organism. The rind is a complete covering of living, active cells which

[fol. 255] protect the fruit from the attacks of the fungus. But let some of these cells be killed by a bruise, or a scratch, or a cut—an abrasion of any kind—the fungus spores will germinate and grow at the injured places when the proper conditions of moisture and heat are present. These conditions usually exist in the packed box of fruit.

These facts were worked out in California on a large scale in both packing houses and laboratory. Sound fruit covered with spores held in rooms where both the temperature and humidity were kept very high for two weeks showed practically no decay. Injured fruit under the same conditions always rotted.

The same principles were worked out in packed fruit and fruit in transit.

This general principle—that the blue mold has not the power to penetrate the sound healthy skin of the fruit—was the only thing in the nature of "a theory" brought into the Florida work at the start. Will the principle of the relation of handling to decay hold true in Florida as it did in California? There were no previous theories other than this, and the workers set out to ascertain the actual facts by careful investigation and experiments. A close study of the conditions of handling oranges from the tree to the packing house, into the box and then through to the markets was made. A large amount of data have been accumulated. Fruit from different sections, and grown under different conditions was studied and the work was extended through several seasons. All effort was made to have the work done under conditions as practical and as nearly commercial as possible. This has been no simple "laboratory" experiment.

In brief: It has been found to our full satisfaction that the general principles relating to the behavior of the blue mold and the relation of handling to the occurrence of decay are as true for Florida as they are for California. There is a definite relation between the handling of the fruit and [fol. 256] resulting injury, and the decay caused by blue mold.

It was found further that the Florida orange is more tender and more easily injured; yet sound uninjured Florida oranges do not rot any more than sound California oranges, all conditions being the same. Conversely, injured Cali-

fornia oranges are just as susceptible to rot as injured Floridas under like conditions.

This is a very important point and is really the crux of the whole matter. There are sufficient facts and data to prove to our full satisfaction the application of this general principle for Florida conditions.

What remains now to be done is to demonstrate the application to the Florida growers. Our work, then, in the future will be in the nature of an educational and demontrational campaign using the data we have obtained as the basis of the work. The work of the past two seasons has been in the nature of such a campaign and next season, at least, it is planned to extend the work along these lines. The work has not been as extensive in the past as we would have liked to have it, owing to the lack of men and money. Last season the frost cut the work far short of what was originally planned.

In order to make our educational campaign effective and of real value we must have the active and hearty co-operation of all the growers. We have had excellent co-operation in the past. We need more of it. It is not sufficient to give us respectful attention or tolerance. We need active support and interest.

The application of the principles worked out are more difficult in Florida than in California. Industrial conditions are different. Weather, climate and seasonal conditions are different.

We have found the California Fruit Growers' Exchange a great help in disseminating the results of our work in California. The Florida Citrus Exchange organized this year has been of great assistance in extending and using the work and its results. More growers can be reached [fol. 257] and with less effort than without the organization. The establishment of new packing houses with improved equipment has helped. The taking over of picking and handling to be done by gangs working under trained foremen has materially assisted in making our work more effective. This is not said with any lack of appreciation of the valuable co-operation which has been given by individuals and independent shippers and handlers, and we hope to continue to receive their active support.

I had a trip through many of the Florida citrus districts last winter. From what I saw it is apparent to me that more careful and better methods are being sought and the desire to improve handling conditions is general.

Four years ago, Tenny stated before this society that a conservative estimate placed the loss from decay of oranges in transit from Florida at from 10 to 15 per cent. We do not know what the average loss was last season. But now we do know that by far the greater part of any such loss is preventable if care is used in the preparation of the fruit for market.

Last season the work of gathering picking and handling data was continued. This actually became an inspection of the work being done in different groves and packing houses. In several instances the inspection of the work of particular gangs of pickers was continued throughout the season, the results being used to demonstrate the necessity of doing more careful work. In this way, also, the careful and careless workmen were discovered.

Last season's investigations also included a series of washing experiments. These were carried on to determine the effect of washing Florida oranges.

A series of shipping experiments was also started. These included a comparison of sound fruit carefully handled and packed with the same fruit handled and packed under ordinary commercial conditions. Part of each lot was packed and shipped the same day it was picked, and parts two and four days after picking.

[fol. 258] Picking and Handling Investigations

This work was done at Arcadia, Bartow, Bradentown, Florence Villa, Clearwater, Largo, Dunedin, Sutherland, Palmetto, Wauchula, Winter Haven and Winter Park.

The first year of our work, 1906-7, the total average of injuries for all the fruit examined was 12.4 per cent., including clipper cuts and other types of mechanical injuries. (scratches, punctures, etc.), and 6.7 per cent. long stems.

The accompanying table shows the results of these inspection records during the past four years.

Table I.

	1906-7 P. ct.	1907-8 P. ct.	1908-9 P. ct.	1909-10 P. ct.
Clipper cuts	5.7	5.5	3.4	3.25
All other injuries	6.7	8.8	3.3	9.9
Long stems	6.7	9.2	9.3	7.3
Total injured	12.4	14.3	6.7	13.15

The averages of clipper cuts are about the same for the first two years. There was a material reduction of this type of injury during the last two years. It can be reduced still lower under actual commercial conditions.

There was a material increase in the percentage of mechanical injuries other than clipper cuts found during 1909-10. It is probable that this figure is too high to represent average conditions of the entire State. Owing to the cold weather the data are not as complete as we would like to have them. The figures show, however, that there is room for much improvement before the standard found possible under large commercial conditions is reached.

The table shows a high percentage of long stems. It is important that this percentage be materially reduced. A prominent grower of California has said that he fears long stems more than clipper cuts. "A clipper cut orange," said he, "is finished and the injury is only to itself, but a long stem is like a murderer turned loose." One long [fol. 259] stemmed orange may injure several others in the course of handling and packing.

Is it possible to handle oranges carefully enough on a commercial scale to eliminate injury? I find that there was considerable discussion on this point after the reading of Mr. Tenny's first paper before this society. Many of the growers seemed to doubt that it would be practicable under Florida conditions to handle without injury. The best answer to the question is the fact that it is being done, not only in California, but in Florida also.

The accompanying table shows the records obtained last season in different packing houses.

Table II.—Percentages of Clipper Cut Oranges and Long Stem in Different Packing Houses, 1909-10

		Clipper Cuts Per cent	Other injuries Per cent	Long stems Per cent
General average		3.25	9.9	7.3
Houses separately	1	1.1		1.0
	2	2.7	6.6	2.7
	3	4.2	1.1	3.5
	4	4.5		4.2
	5	5.0	7.4	3.6
	6	5.0		4.3
	7	4.8	2.0	7.4
	8	1.3		8.7
	9	3.9		2.0
	10	4.0		19.2

The figures show a very wide range. Some are very low and below the average. The range is from 1 per cent. clipper cuts to 5 per cent. The range of long stem percentages is still greater running from 1 per cent. to 19 per cent. In two instance both the clipper cut and long stem percentages are very low, showing very good work being done. In a number of cases, however, the reduction of clippers cutting seems to have been obtained at the expense of making long stems. This must be avoided. In California the rule of making two cuts to every orange not in plain sight has been adopted. This results both in the reduction of long stems and clipper cuts and also does away [fol. 260] away with the picker dropping the fruit directly from the tree into the bag or basket.

The following table shows the records of a picking gang at the beginning of the season and later after the inspections and instruction of the government workers had their effect. The table also shows the results obtained in the same district by a grower who insisted on doing his own picking and another record of fruit picked by a gang working under the box-payment plan.

Table III.—Orange Picking in One Locality in Florida, 1909-10

	Clipper cuts Per cent	Long stems Per cent
Commercial picking, before instruction, careless	5.3	4.0
Same gang as above, after instruction, careful	1.3	1.0
Picked by owner	7.0	20.0
Picking by the box	9.8	23.7

The figures hardly required explanation. They show that it is possible to get good work done. Everything depends on the foreman. The plan of inspecting each picker's work during the day's run is the one adopted to hold injuries and long stems in check. In this way the pickers who are doing rough and careless work are discovered and can be reprimanded or eliminated. The man who habitually handles roughly and cannot or will not be careful must be discharged. He is an expensive workman at any price.

Naturally, it will cost more to handle in this way. But there are ample examples to show that it pays well to do this. I am more familiar with conditions in California, but I dare say there are examples in Florida sufficient to prove this. If the saving in the fruit alone is taken into consideration, there is ample saving to pay for careful work. If we add to this the value of the reputation for soundness and holding quality on the market, the extra cost will be returned many times over. In California frequently differences of from 25 to 50 cents and even more per box above the ordinary market prices are given for [fol. 261] brands which have a reputation for soundness. It is impossible to estimate the money value of a good reputation.

In California it has required the reorganization of the business of handling the crop in order to insure careful handling. The insistence of quality of work instead of quantity has necessitated a close supervision of the handling both in the groves and in the packing houses. More and more, associations are taking over the picking, putting in gangs working under efficient foremen. Some associations accomplish good results by having a rigid system of inspection, insisting that the grower do careful work.

With the number of new associations which are being organized in Florida, it will be possible to introduce better methods. Good work must be made the basis of the business and it will be necessary for the association to exercise close supervision and possibly control of all operations of handling the fruit from the tree to market.

Washing Experiments.

These experiments were made in order to determine the amount of injury and decay resulting from washing. Washing is necessary where the fruit has been blackened by smut following white fly scale. It seems to be a mistake to wash simply because it is supposed to improve the appearance of the fruit. In California our investigations demonstrated that decay bore a direct relation to the amount and character of the handling to which the fruit was subjected. As a result, all unnecessary handling was eliminated. Many houses discontinued dry brushing when it was shown that brushing might be responsible for heavy decay.

When the California work was begun, it was commonly supposed that fruit produced near the coast was weaker and had poorer carrying quality than fruit produced inland away from coastal influences. Unquestionably there was heavier decay in the coast fruit. It was found that this was not an inherent quality of the fruit itself. It was due to the extra handling necessary to put the coast fruit in [fol. 262] condition for shipment. Washing was found to be largely responsible for the heavier decay in the coast fruit. Owing to scale, fully 90 per cent. of the coast fruit had to be washed, while little if any of the inland fruit required washing. By subjecting the inland fruit to the same conditions of washing it was shown that decay was nearly as heavy as in the coast fruit, and that if the coast fruit did not require washing it had practically as good holding quality as the inland fruit.

The result also showed that in the operation of washing considerable improvement could be made. For example, much greater decay followed washing in dirty water than when clean water was used. There was also considerable difference resulting from the use of different machines and the speed and manner of operating the machines.

The experiments made last season in Florida were

designed to show the effect following washing of Florida oranges. The chart and table show the averages of all the washing experiments made in Florida.

Table IV.—Average Percentages of Blue Mold Decay Following Washing of Florida Oranges, 1909-10

Not washed Per cent		Washed Per cent
1.2	Careful picking	4.2
2.6	Ordinary commercial picking	6.9
	Long stems	9.8

The figures show that there is an increase of decay following washing. The washed carefully picked fruit shows more decay than the not washed commercially picked fruit. There is also more increase of decay following washing of the commercially picked lots.

The high percentage of decay following the washing of long-stemmed fruit is significant. The picking data presented show that stems are common in Florida picking. When such fruit has to be washed it is important to have both the picking and the actual washing work done as carefully as possible.

[fol. 263] Shipping Experiments

Our shipping experiments last season were not satisfactory in that the work was seriously curtailed by the frost and the continuity of the experiments was destroyed. It is felt that the data are too meagre to justify any definite conclusions. We need much more data and it is hoped that the experiments can be extended next season.

The plan last season was to ship experimental series consisting of sound fruit handled and packed very carefully under the supervision of the bureau workers, in comparison with the same fruit picked and packed under ordinary commercial packing house conditions. Along with these, lots made up of selected injured fruit were to have been included. The plan also included the holding of the fruit after arrival to study its market holding qualities for three weeks, inspections being made on arrival and one, two and three weeks after arrival.

A study of the delay in packing and shipping was also attempted. For this, part of the lots were packed and

shipped the same day they were picked, part held two days and part held four days before packing and shipping. Only a small part of this work outlined was carried out owing to the cold weather.

While the data are too meagre to be definitely conclusive, they show, (1) That the least decays follows immediate packing and shipping; (2) That there is least decay in the carefully handled fruit and most in the injured; (3) That there is less decay following delayed carefully picked fruit than delayed commercially handled or injured fruit.

Sound fruit stands the delay without serious loss, but where there are considerable amounts of injuries present, the quicker the fruit is packed and shipped the less the decay shown on arrival.

In the holding tests after arrival, the carefully handled fruit showed a very great advantage. The average of the few shipments we were able to make was 5.2 per cent. decay after three weeks holding of the carefully handled lots, [fol. 264] while the commercial packs showed an average of 10.8 per cent. after the same length of time. The same relation is shown by the delayed lots. The carefully handled lots delayed 2 days before packing showed 5.1 per cent, after 3 weeks in the market, and that delayed four days showed 7.3 per cent. after the same time.

The delayed commercial pack after three weeks showed 15 per cent. for the 2-day delay and 20.2 per cent. for the 4-day delay.

These results are consistent with the results of our California shipping work which was based on a large number of shipments. I have no doubt that similar results will follow the extension of the shipping investigations from Florida.

Discussion

Mr. Temple: May I ask the professor whether his figures of percentages of washed versus unwashed fruit are the sum total of all his washed experiments, or just a specified text? Is it not true, however, that under certain circumstances there was not only no greater decay but in some cases less decay on the washed than the unwashed fruit?

Mr. Stubenrauch: It sometimes happens, that there is practically no difference, and in some instances there is less

decay in washed fruit; but it would be unsafe to infer from this, that washing prevents decay.

Mr. Temple: Now, of course, it is hard to go up against a proposition where the scientific men have carefully compiled statistics to prove their point to you. But in my experience, I am certainly led to believe that careful washing will remove some of the conditions which tend to cause decay, that may be present before washing. I do not believe that washing the fruit, when it is done as it should be, makes it more liable to decay, nor, of course, do I believe that mechanically injured fruit will not decay even if carefully washed.

[fol. 265] It really does seem to me that there are some cases where the washing of fruit seems to remove something that causes the decay.

Mr. Strubenrauch: Please understand that I am not prepared to state positively that washing will or will not injure the fruit. I have simply described our tests and the results which have caused us to form the conclusions we have.

Mr. ——: I would like to ask if any success has been met with where antiseptics are used in the wash.

Mr. ——: I tried one experiment. I washed the oranges with water in which there was a small percentage of salicylic acid. After several days the oranges were carefully examined and the decay was found to be practically zero.

Mr. Stubenrauch: We tried a number of these experiments in California, and had a man there one season working on that alone, but we did not get any results that were worth noting.

Mr. Young: Has it been found that there was any different percentage of decayed fruit caused by the different washing machines?

Mr. Stubenrauch: I have no doubt that some machines do more injury than others. It usually goes back, however, to the man who runs the machine. One man can get good work done by a machine, where another can do a whole lot of injury. The same is true of clippers. One man can take a rather undesirable pair of clippers and bring in his fruit in good condition, while another man with a much better clipper brings in his fruit in poor shape.

Mr. Porcher: I would like to ask the professor—and I do not intend to criticize his investigation—if it would not be possible to get descriptions in detail of the machines and the methods, that we may have instructions and advice that will be beneficial. I am quite positive that oranges can be washed with benefit to the fruit and the growers' pocket, [fol. 266] but I am also aware that unless the machine is properly handled, it will do great injury.

Now, if we could have plain statements from someone who knows as to the best machines, whether sponges are used, what number of sponges, the flow of water passing through the cylinder, and such information as this, I am confident that it would be of interest and profit. We take it that the professor knows all about the proper machine for washing fruit; how it should be run and how it should be maintained. There are many machines that are perfect in their way; on the other hand, I have seen machines where there is a lack of sponges, where the lining has been ripped or torn and the fruit jammed under the lining, and the odor from one of these machines was distinctly apparent. One of the best things we can have around the place, is a man with a good smeller. He can detect lots of things that way that might otherwise go unnoticed.

Mr. Stubenrauch: You can get the information you want from the Department of Agriculture, or from some of the society members who are washing their fruit successfully.

I agree with you as to the difference in washers. I went into a number of packing houses in Florida last winter, and, as you say, there were some houses I didn't want to go into without a handkerchief over my nose. Others were being run on very satisfactory lines and were turning out fruit in fine condition.

Mr. Porcher: I had a party of friends in the house and they wanted to see my machine in operation, so they went down to the washer just as they were dressed; they were in evening dress; my wife was one of them. They finally took charge of the washer; just pinned up their skirts so that they would not rip over them, and did all the work themselves, and I don't think there was a spot or a stain on any of their dresses.

Now, along the lines of injury where water touches fruit. I took a box of fruit and dumped the contents carefully into [fol. 267] a ditch. I wanted to try a little experiment to know just what damage it would do. The fruit remained there several days. I removed the fruit and found one orange pretty badly decayed, but that particular orange we had noticed before putting it into the water and had remarked at that time that there was a sign of blue mold on it. The fruit was washed off very carefully, and then we examined it and found it absolutely uninjured, and we packed it and marked it and shipped it, and it carried in good order. The point is that moisture does not injure fruit that has been carefully handled and is not cut or bruised.

Mr. Stubenrauch: That takes you right back to careful handling. You get a machine that is all right with a careful man to run it, and you may get the fruit washed without injury, provided care has been taken with it all along the line, but if you have a lot of injured fruit coming in from the grove and put it through the washers, you will give it ten chances to one to be made more subject to decay.

Mr. Hart: Now, take the matter of clipper cutting or long stems. Don't you find a marked difference between different varieties of oranges in regard to that? Take the pineapple orange; there is no need of anyone clipper cutting a pineapple orange or of getting long stems.

In California, I noticed that the stem of the orange is in more of a pit; the orange is rough around the calyx and is very subject to clipper cutting, making it much more difficult to clip the stems close; therefore they do double clipping. The more careful growers and shippers have their fruit clipped twice. It seems to me that would be entirely useless with the Florda orange, as grown in most portions of the State.

A great many have told me it was impossible to get their fruit clipped properly. I work twelve to fifteen hands, but it isn't very often I have to discharge a man because he does not do his work right. I sometimes find good work- [fol. 268] ers who are mentally weak and in two instances I decided that it was impossible to teach them to do good picking; but as a general thing I have no difficulty in train-

ing men so that there will not be more than one or two per cent. of long stem oranges.

When these go into the washer, every one of them is examined. Either the eye or the thumb or the finger gets into the calyx and if the stem is long it goes into a box to be gone over and clipped before being washed.

I think it is safe to say that if the fruit is picked properly and washed properly with a Warner washer, it does not do it any injury to be washed. I have tested it repeatedly in the years gone by, washing some and leaving some unwashed, and putting the two side by side, and in every instance so far, the washed fruit has stood up the best.

I am afraid of brush washers. They may be all right, but I am afraid of them. I am not advertising the Warner washer, but I have tested that more thoroughly than any other and I believe it is absolutely safe if properly handled, but it is not properly handled in many cases. Either the operators do not gauge the fruit so that there is the proper holding back or resistance to its going through, or it is overloaded; some rivet head or other roughness inside the cylinder is not looked after and done away with, long stems are overlooked or too little water is used. The principle is simply a lifting up and rolling down of both sponges and fruit, and with right conditions no harm can result.

I believe a great deal of the injury in the washers is in the improper handling of the washers themselves.

Mr. Stubenrauch: I do not doubt that you are right. I can cite an example that came under my own notice. Out in California we were able to compare the same machine being handled by two different parties. It happened that in one place a machine was causing considerable—that is, we were getting a large percentage of decayed fruit from the lot washed with that machine. The house had great faith in the machine itself, but we were almost ready to [fol. 269] condemn it. We don't, as a rule, advocate or condemn any machine. However, we happened to run across a case of the same machine being used with practically no decay at all in another part of the State. This as you see, brings us back to the old question of the "man behind the gun."

Now, as to the matter of long stems; that is a very important matter. Your fruit is very tender; much more so than the California fruit; full of juice and thin skinned. In the washing, the oranges are knocking against each other; if there is a single orange with a long and jagged stem, it may do a whole lot of damage.

Another matter comes to my mind, and that is the clippers. You have to watch out very carefully to keep them in good condition. You will find that your work will be much more satisfactory if the clippers are kept sharp and close so that you do not have a jagged stem. We find a great deal of difference when the clipper is kept tight instead of loose and dull. When the clipper is in such bad shape that the stem is broken off instead of clean cut, it leaves a sharp point or points that will do a great deal of injury.

Mr. Hart: I think it makes a great difference as to the clippers you use. I have clippers which have been sent to me to test. I won't say that I have had samples of every kind of clipper, but I have had a good many. I have not reported on but one or two of them because I have found that they were not properly made. A great many of them have the bevel side on the side next the orange and it would be so long that you could not get close enough to the orange to cut it off properly. To get that bevel just right seems to be the most difficult thing for the manufacturers to do.

Mr. Stubenrauch: I don't think any of them get it just right, Mr. Hart. I have never seen one that was just right.

Mr. Hart: I attacked that problem and got results that were pretty satisfactory, but afterwards there was carelessness and the clippers were not kept in first class shape. [fol. 270] To get the best results, the clippers must be given attention, but if the clippers are made right, you will escape getting the clipper cut fruit.

Mr. Temple: Mr. Hart stated that while he had had no experience with the brush washer, he does not like it. Now, I would not discuss the brush washer if I was not familiar with it and had not used it. I have used two all winter. On one occasion, when some tests were made, some fruit was packed, unwashed; other fruit was packed, washed through the brush washers. At the end of three weeks we opened the fruit and found three decayed oranges in the

box of unwashed fruit and two in the box of washed fruit. After the fruit was opened and examined, it stood in the packing house for more than two weeks and finally they asked me what to do with the brush-washed fruit. I told them to repack it and send it to a hospital in Orlando. We didn't want to ship repacked fruit. They repacked the fruit, sent it — the hospital, but it seems they had just re-received a consignment of other fruit sent to them. It stayed around the hospital for a while, and they finally turned it over to a grocery store to sell the fruit and turn the money over to them, as they needed the money more than the fruit.

When I discovered that a grocery store was selling some of our fruit at retail, I looked into the matter to see how they got hold of it, and traced back and found out that it was the self-same box of fruit. I watched very closely the sale of that fruit to find what percentage of decay showed up in it. The fruit was all sold at retail, taking probably two weeks in the sale, and while the unwashed fruit showed almost one-half decay, the repacked, washed fruit did not have a single sign of decay when it was sold here seven weeks after it was originally packed.

Mr. Kilgore: We had a washing experiment in our packing house which turned out practically the same. The company got in a new brush washer. We were afraid to use it, but to get it "broken in" we washed the fruit in a car which had been standing on our siding for some time. [fol. 271] After the oranges were washed, the water was pretty greasy. To see how the experiment worked, we packed a few crates of the washed and of the unwashed fruit. The unwashed fruit rotted very badly and the washed fruit rotted very little.

Mr. Stubenrauch: Your washed fruit was probably selected fruit. Of course, in that case it would be hard to make a fair comparison.

Mr. Kilgore: There was no selection.

Mr. Stubenrauch: I think all of this discussion confirms the facts brought by our work regarding washing. All of the gentlemen who have shown that they are not getting decay following washing are in a class of handlers far above the general average, and the handling of the fruit in their houses is being very carefully done. Our results show, both

here in Florida, and in California, that every extra process or handling that has to be given the fruit is a place where injury is liable to occur, and that where these processes are necessary to place the fruit in marketable condition, the necessity for extreme care becomes doubly important.

Mr. Stockbridge: Speaking about the additional care that has so much to do with results. The packing of fruit certainly has a great influence on the amount of decay. I would mention that I have always taken pretty good care of my fruit and yet in spite of ordinary precautions, the percentages of decay were quite large. My crop of 1908 showed that the average percentage of decay was between 15 per cent. and 20 per cent., and yet my fruit was pretty well put up, too, and I suppose that as the average man goes, I put my fruit up about as well as the best of them and took about the same precautions.

Now, after attending the meeting of the society at Daytona last year, and hearing the report of the committee on the investigation of the packing methods of California, I went to my grove and talked matters over with my superintendent and when we came to ship the next crop, that is the crop of 1909, I made a careful test of what I hoped were [fol. 272] better methods. I shipped a carload to Atlanta and had it opened by three or four commission men. There were sixty-five boxes out of the car I opened myself personally, and out of the sixty-five boxes there was not a single decayed orange. I don't suppose out of the whole car there were forty decayed oranges. We did not wash the fruit, but we used the clippers distributed by the society last year and kept them sharp, and every man who went into the grove or packing house, wore gloves. Everyman's finger nails were kept short and protected. The result was a saving of about 15 per cent. in decayed fruit.

It was my fruit that was chosen for the Taft banquet at Atlanta. They searched all over the city to get fruit they thought was good enough, and finally purchased twenty-eight boxes of my fruit for that occasion.

Stem End Rot

Prof. H. S. Fawcett

Mr. President, Ladies and Gentlemen: Stem end rot of citrus fruits is perhaps one of the most serious diseases

with which the orange growers have been called upon to contend. As if we did not already have our share of troubles to keep us in a humble condition of mind, this new plague sweeps down upon us and threatens the destruction of the sound fruit itself after we have brought it safely past all the other enemies that threaten it. A somewhat similar disease of lemons in California, called the Brown Rot, threatened the very existence of the lemon industry there. Preventive measures were worked out by the California Experiment Station after a good deal of study and the lemon growers have so learned to handle the crop that little trouble results. It is possibly along similar lines that pervention of the stem end rot will lie. We expect to carry out some extensive experiments for the control of this disease this next season and we will try out some of the best methods found by the California Station as well as other experiments suggested by the study of the fungus.

[fol. 273] It is important to investigate this decay at once, to see if there may be any means of preventing its spread or of keeping it out of a grove or locality where it is not already found. The decay has become most serious already in a number of localities in the State. It appears to be most prevalent in Volusia, Lake, and Orange counties. Our correspondence has shown that it is found in at least 20 towns scattered over the middle part of the State from east to west, but probably worst in the three counties mentioned. It is difficult to predict what it will do next year. It may be worse or there may be different conditions of seasons and weather so that very little trouble will result from it. (The conditions influencing the occurrence and spread of the disease is a feature needing our study and investigation. There are a number of things about it that are quite puzzling, but when we come to understand the life habits of the fungus causing it better, we will perhaps then be in a position to explain these things.)

The amount of loss from this disease during this year is rather difficult to estimate, since it varied a great deal between different localities and different groves. In one locality in Volusia County the loss from dropping of fruit was extensive. In one grove which I visited that had been well cared for and in which the trees looked in good condition, it was estimated that one-third of the grapefruit dropped, due largely to the stem end rot. One-fourth of the

oranges were said to have been lost in the same grove. In another grove ten miles from this one, 10 to 50 per cent. of the fruit was on the ground by the first of December and a large percentage of this fruit developed the stem-end rot, mostly after they had fallen from the trees.

History

The first knowledge that I had of the existence of this disease was in November of last year when 4 specimens of grapefruit were sent from Volusia county. Two of these fruits showed a softening at the stem end, without at first [fol. 274] any discoloration on the outside. On examining the interior of the rag and pulp cells under the microscope, large fungus threads were seen which appeared to be quite different from any that were known to occur in connection with other decay of fruits. Cultures of this fungus were obtained from these fruits by the ordinary laboratory methods.

The fungus when it grew up in the culture dishes was different from any I had before seen in connection with citrus fruits. In a day or two letters came from two or three other places indicating that the trouble was more general. We then began to realize the seriousness of the situation and I began some preliminary experiments to see if I could infect healthy oranges with this disease. I began first with grapefruit and then oranges, and found that almost invariably the fruit on which cultures of the fungus or on which pieces of diseased oranges were placed at the cut end of the stem, began to soften in from a week to three weeks' time.

Description

The fruit begins to soften and sink a little round the stem end, without the rind changing color. There is no blackening or moulding at first, and the rind remains intact over the softened interior. The rot proceeds inward along the fibers of the rag, and then outward to the pulp cells. At first both the inside and the outside of the fruit remain almost unchanged in color; but, as the softening goes on, the rind turns dull brown. Finally the rag and the pulp cells are disintegrated, and the entire fruit becomes soft and mushy.

This rot usually occurs on full-sized fruits after they have colored. Though the softening may begin while the fruit is still hanging on the tree, it usually develops after the fruit has dropped or after it has been picked.

The stem end rot is mainly but not entirely a decay of fully mature fruit and is usually seen on fruit after they have dropped or have been picked. The characteristic softening does sometimes occur while the fruit is still hanging to the branches. This shows beyond doubt that the fruit may be attacked while yet on the tree, that in [fol. 275] some way which we do not yet know, the fungus gets to the oranges on the tree. How early in the development of the oranges the fungus may attack them I do not know. One grower who has had some stem end rot for two or three years past said that he first noticed it a little in September. At that time he said the fruit as they hung on the trees showed circles around the stems which ripened up sooner than the other part of the fruit. This would indicate that the fungus may make its attack at least as early as the first or middle of September while the fruit is still somewhat immature. The same grower said that the rot was very noticeable by the middle of October and at its height by the first week in November. Long hot dry spells, rain, and cooler weather seemed to check it. As said before, the symptoms of the decay usually show most on dropped oranges after they have lain for some time upon the ground. In most of these cases it is reasonable to suppose that the infection with the fungus is the direct cause of the dropping and that the signs of the decay develop later after the fruit has dropped to the ground. In several instances where suspected fruit was picked from the tree and laid out on the table in the laboratory, they afterward developed the decay. The fact, too, that it took from a week to three weeks for the softening to show after fruits were inoculated with the fungus shows that infection must take place one to three weeks before there are any outward signs of decay.

If the decay of fruit showed only on the trees and on the ground it would be serious enough, but this is not the end of the trouble. The decay develops on the way to market in spite of any of the known precautions used for preventing decay from the blue mold or other rots. This is the most serious phase of the trouble. As has been indicated, the investigations as to the cause brought out the fact that it

could be started directly by inoculations of a species of fungus. A study of this fungus was made to find out what its nature was. At first we thought it might prove to be the [fol. 276] same one that causes the Brown Rot of lemons in California, but after some study I decided it was a species of *Achlya*. The species of the genus *Achlya* are water moulds. They live normally in ponds and ditches, and fresh water streams. None of them as far as I know have before been known to be parasitic on plants, although some of the forms related to Achlya are parasites of insects and plants.

Two questions will probably present themselves to your mind. Where did the fungus come from in the first place and how does it get up into the trees to infect the oranges? To both of these I will have to say I do not know, except that it evidently lives in the soil. I am trying to answer the latter question as to how it gets into the trees. The fact is that it gets to the tree and just how is only a conjecture. I find in some cases kinds of bunches or coils of fungus that develop when the fungus grows up into the air, out of liquid cultures. It is my theory that these act as a sort of spores to carry the fungus from the soil or from previously rotted fruit to the fruit on the trees, but this remains to be proved.

Inoculation Experiments

I shall now confine myself to facts and leave theories and speculations. The decay is highly infectious as will be seen by examinations of the results of some inoculation experiments carried on at the Experiment Station laboratory. To find out just how the decay could be transmitted to sound fruit I started a number of different experiments.

First we placed pure cultures of the fungus on the stem end and on other parts of the surface of sound fruit. We also placed pieces of previously rotted fruit on the stem end of other fruits. We also wished to determine whether or not the fungus could get into the fruit through the attached stems. For this purpose we had oranges shipped in from a point where we had been unable to find a trace of the stem end rot, with stems of various lengths from 3 inches to 1-2 inch.

The accompanying table shows the result of these tests. We kept check in every case. This experiment shows that [fol. 277] infection may be produced easily through the stem end, but with more difficulty through other parts of the

surface. In most of these tests the oranges were kept at a temperature of 85 degrees F. in an incubator. In my last press bulletin I said that infection seemed to take place only through the cut end. This was based on some preliminary experiments at room temperature during the month of December. At the cooler temperature at that time no infection took place except at the stem end of the fruit. Since that time I have found that infection may take place through other parts of the orange. Infection also takes place easily under laboratory conditions through stems 3 inches and shorter.

Table No. 1

Manner of inoculation	Percentage of decay
Cultures on blossom end	43
Cultures on calyx, cut end waxed	60
Cultures on end of stems, stem 3 inches long	45
Cultures on end of stems, stem 2 inches long	50
Cultures on end of stems, stem 1½ inches long	100
Cultures on end of stems, stem 1 inch long	100
Cultures on end of stems, stem ½ inch long	100
Cultures on end of stems, stem 0 inch long	100

This table shows the percentage of decay in oranges from inoculation with pure cultures of Stem-End Rot fungus. The figures are taken 3 weeks after inoculation. Small bits of fungus were placed on parts indicated and a piece of wet cotton placed over them. The oranges were then wrapped as for shipment and kept at 85 degrees Fahrenheit.

We also wished to determine whether infection took place from the fungus in water. Fruits were soaked in water containing cultures, for varying lengths of time, and others in water containing pieces of diseased fruit and still others in soil from under diseased trees.

As checks some test fruits were also soaked in pure water under identical conditions to those above. The second table [fol. 278] shows the results of these experiments. These experiments show very clearly that infection may take place through the medium of water by means of pure cultures of the fungus, by means of pieces of previously rotted fruits, and by means of soil from under infected trees.

Table No. 2

Oranges

Manner of inoculation	Percentage of decay
With cultures in water, 4 hrs.	25
With cultures in water, 7 hrs.	50
With cultures in water, 24 hrs.	40
With diseased fruit in water, 4 hrs.	50
With diseased fruit in water, 7 hrs.	100
With diseased fruit in water, 24 hrs.	90
With soil from under infected tree, 3 lbs. in water 24 hrs.	75
Soil, air dried 16 days, 3 lbs. in water, 24 hrs.	12
Check. In water only—24 hrs.	00

Lemons

With cultures in water, 24 hrs.	64
Check. In water only—24 hrs.	00

This table shows the results of soaking oranges and lemons in water with pure cultures of fungus, or with pieces of diseased fruit, or with soil from under infected trees, as compared with soaking oranges in pure water. After soaking for stated time, each fruit was wrapped as for shipment and kept at about 85 degrees Fahrenheit. The figures show percentage of decay from Stem End Rot in 3 weeks after inoculation. Those soaked in pure water showed no decay from this cause.

Having found out something about the habits of the fungus, how it infected the fruit, etc., the next question was to try some experiments to see what would prevent infection. Since the disease was somewhat similar to the Brown Rot of lemons in California we planned an experiment similar to one that had been carried out for that disease. We placed cultures of the fungus in jars of water and at the same time put into it certain disinfectants. We used copper [fol. 279] sulphate, formalin, potassium permanganate, iron sulphate and ammoniacal solution of copper carbonate. The experiment indicated that the copper sulphate, copper carbonate and potassium permmanganate would prevent infection, but it was not at all conclusive since it was found

that the oranges on which the experiment was tried proved afterwards to have been affected with stem end rot before being treated.

Treatment

Treatment or preventive means that suggest themselves as a result of study of the fungus and our experiments in infecting oranges and in preventing infection are of two kinds: (1) Treatment in the grove to prevent the infection of fruit on the trees, and (2) in case oranges must be washed, treatment at the packing house to prevent oranges from infecting one another at the washer. Probably the most feasible treatment in the grove will be to use the ammoniacal solution of copper carbonate. This should probably begin as early as the first of September or sooner, judging from the reports we have of the time when the decay begins. Bordeaux mixture could be substituted for the ammoniacal solution at this time, and the ammoniacal solution used later when there was danger from staining the mature fruit. I tried some experiments with the ammoniacal solution of copper carbonate in December, but this was probably too late to get any marked results. However, the treatment did show some results, about 10 per cent. less stem end rot being found on sprayed than on unsprayed trees.

This next summer and fall I intend to take up some more extensive experiments in some orange groves. The second line of treatment will consist in treating the wash water with some disinfectant to prevent the fruits from infecting one another in the process of washing. It seems to me this may be done either by throwing into the tank a fungicide as is done for Brown Rot in California or perhaps better in allowing a spray of some fungicide to play over the oranges as they leave the washer.

[fol. 280] To sum up, the facts about stem end rot are that it is caused by a fungus related to the water molds. It attacks oranges, grapefruits, tangerines, lemons, and sour oranges. It attacks the fruits usually at the stem end but may under some circumstances enter at other places. It may be transmitted from diseased oranges to healthy ones by contact or by soaking them together in water. The fungus may infect oranges through a stem at least three inches long. Oranges may be infected by placing them in water with soil from under trees from which decayed fruit has

fallen. It takes from one to three weeks after infection at ordinary temperatures for symptoms of the decay to appear.

The probabilities are that the fungus has spores or aggregations of hyphæ by which it is carried to the oranges while on the tree. It is probable that the fungus infection may be easily prevented by spraying with some fungicide early in the season. It is quite probable that any new infections after packing can be prevented by a fungicide in the washer. It is also quite probable that we will find that it is influenced by some climatic or weather conditions or some weakened condition of the trees. This is about the sum of our information and probable theories at present. As we come to learn more about the habits of the fungus and the conditions that enable it to attack the fruit we will probably be in a position then to suggest an effective remedy.

Discussion

Prof. Hume: I have heard a good many discussions on the subject of diseases of plants, but I do not remember to have heard a clear and more intelligent paper than that we have just listened to. I must say that the subject of stem end rot has been most admirably handled.

Mr. Hart: I would like to ask if, when you are treating oranges, it would not be best to do it before they go in [fol. 281] the washer. It seems to me that the experiments would indicate that if there were any spores on the fruit, they would infect any of the fruit that goes through the washer.

Mr. Temple: I think I can give you a little information on that point, having had more experience probably than anyone in the State. It would be very well to treat this fruit before it goes through the washer or cull it from the sound fruit, if there was any way you could tell just what fruit was affected, but it comes into your packing houses seemingly perfectly sound. I have packed it and let it stand in the house, and in twenty-four hours the box would be a perfect mass of pulp.

One way you can tell is to cut the orange in half from the stem end down, but it would be pretty serious if you had to test all your oranges that way. If you cut the orange at right angles from the stem end to the blossom end, you will find a little mealy white speck which looks very much as

though the fruit had been frosted; then there is a slight brownish discoloration, and the fruit has a decidedly spoiled odor, but from the outside of the orange you could not tell to save your life whether the fruit was or was not affected in this way.

We were almost ready to start packing oranges in the fall when two of our clients came to us and told us we must pack their fruit right then. We investigated it carefully and found a lot of fruit on the trees that was ripe, so we started to ship and that was where we first discovered the stem end rot in our section. I sent some to the Experiment Station and some to Washington.

I have tried various things in the soaking tank; ammoniacal copper carbonate and other things, but it does not seem to help any.

Prof. Fawcett: I believe the infection of the stem end rot which shows up after the fruit is packed is made either before or during the time it is going through the washer. I believe additional infection might take place in the washer, but if you treated them after they came out, it would destroy the danger of infection. The twenty minutes or so the [fol. 282] oranges are in the bath would not be time enough for the fungus to grow into the rind.

I believe a feasible way to prevent infection from the wash would be to have a fungicide sprayed upon the fruit when it comes out of the washer. I suppose many of the fruit are infected on the trees through the rains and dews, possibly.

Mr. Skinner: How about permanganate of potash? Would a spray of that be effective. That is what they are using in California and what I used this year.

Prof. Fawcett: They use that in California for Brown Rot and it is very good. The only trouble with permanganate is that it stains the oranges, especially if the orange has a rough surface.

Mr. Temple: The trouble with the suggestions that we disinfect the orange after it leaves the washer is this: no matter if you do that, and disinfect every orange that has become contaminated in the washer, the fruit that is already diseased goes through and shows no signs of breaking down, so that you cannot tell the sheep from the goats. After it is packed, it breaks down very quickly and the results on

that box of fruit are just the same as though you had not disinfected it at all.

[fol. 283] PLAINTIFF'S EXHIBIT No. 15

Proceedings of the Twenty-fourth Annual Meeting of the Florida State Horticultural Society, Held at Jacksonville May 2, 3, 4 and 5, 1911

Compiled by the Secretary, Published by the Society

Stem-end Rot and Gummosis

Two Fungous Diseases of Citrus

H. S. Fawcett

MR. PRESIDENT, LADIES AND GENTLEMEN: In addition to the many unfavorable conditions to which the fruit grower is liable, such as frost or scorching heat, floods or drought, or hurricanes, there are the ever-present insect and fungous enemies, new and destructive kinds of which are liable to get into his orchard at any moment without his notice.

It is with two fungous enemies of citrus trees, that have been known and studied during the past one or two years, that this paper proposes to deal. The two diseases associated with these two fungi, are Stem-End Rot and Gummosis. Stem-End Rot is a comparatively new disease. Gummosis has been known for many years, but the fungus associated with it has only recently been studied. To the practical orchardist, the minute details in regard to these fungi are of little interest. He is interested in them just in so far as a knowledge of the habits of growth and life history of the organisms enables him to intelligently con-
[fol. 284] trol them. At the same time, we may realize the importance of careful and painstaking research by the Plant Pathologist into the minutest details of the organisms causing them, because of the fact that this knowledge often enables him to combat a disease at once, which has baffled him for a life time. It is so with these diseases of the orange. A knowledge of their cause is suggesting effective means of controlling them.

What are Fungi?

It is scarcely necessary to say that the fungi are plant growths of very low order and include such names as moulds, mildews, smuts, rusts, toadstools, mushrooms, puff balls, etc. The different kinds of fungi, as is so well known, are exceedingly variable in size, from those 1-1000 of an inch, to those a foot or more in greatest diameter, and in form they vary from those comparable in size to a hen's egg, to those that could be likened in form to a cabbage palmetto, an oak tree, a towering red wood tree, or an Indian mound. The two fungi which have to do with Stem-End Rot and Gummosis of citrus trees are both so small that they can rarely be seen on the trees even with the hand lens, and only the effects of their work appear. When growing in large quantities, however, they appear like differently colored moulds, which are seen under a compound microscope to be composed of innumerable interwoven fungus threads. These fungi keep themselves alive from generation to generation and spread from place to place by means of seed-like bodies called spores.

Control of Fungus Enemies

Spraying is usually the first thing that is thought of in connection with a fungous disease. Spraying has been the great remedy in the past, and is still an efficient means of relief for many kinds of diseases of plants.

While we may never be able to get entirely away from the use of the spray pump and fungicides, I believe that for orange trees at least in the future, the pruning knife, the saw and axe and the burning brush heap, and the planting of resistant varieties, are going to be a far greater factor [fol. 285] than the spray pump, in the control of fungous diseases. It is not the purpose of this paper to discourage spraying for orange disease in its right place and at the right time. Spraying for certain insect and fungous diseases will no doubt always have to be resorted to for temporary relief, as the doctor uses medicine. A doctor will insist on your living and taking care of yourself in such a way that you will not need his services, and yet at the same time, he will prescribe medicine to break up some

ailment which you have let go along until it is serious. It seems that the situation is sometimes somewhat analogous to this in an orange grove. I believe, however, that the ideal we should work toward is to do away as much as possible with the necessity for spraying, as the doctor would advise you to so live as to do away with his medicines.

It is the desire here to emphasize strongly the need for "the pound of prevention," grove sanitation, and care in keeping our trees resistant to an attack of the enemy, of propagating only good healthy nursery stock, and seeking for resistant varieties, and budding our trees to these; and sometime in the future, if possible, throw away our spray pumps on the scrap heap, so far as fungus diseases are concerned. The danger that comes with spraying for fungi in orange trees, is that in many cases while you are killing one enemy, you may at the same time be killing half a dozen fungus friends. Therefore, one must know what he is doing. In using the pruning knife, the saw and the axe, we are not so apt to be killing so many of our friends. It is necessary not only to study each disease in itself, but to study it in relation to other diseases that may be present, and in relation to other factors, such as insects, weather, fertilization, etc. What may be of utmost value under one set of conditions may be all wrong under another different set.

Stem-End Rot of Citrus Fruits

The fungous enemy causing stem-end rot is a comparatively new one. The oval spore of this fungus, about 1-4000 of an inch long gives rise to a filament that enters at the [fol. 286] stem end of the fruit while it is still hanging to the tree, or after it has been picked. If it enters while on the tree the fruit drops and the fungus by means of innumerable branching and interwoven miscroscopic threads, causes it to pass through the stages of decay, for slight softening at the stem end, to brown mushiness and finally to a hard, dark-brown or black mummy. The spurs from which the the fruit has dropped, die back from 3 to 12 inches or more and often show drops of gum near the border between the dead and live wood of these twigs. Spores of the fungus have been found in great numbers on these dead branches and on the mummified fruits, and pure cultures have been

obtained from the interior of these twigs as well as from the interior of softened fruit.

A year ago I gave you my first report on this disease and gave out the information that had been obtained up to that time. The information then at hand was that stem-end rot was a serious decay of sound fruit as well as injured fruit; that this decay developed often on sound oranges in transit; that it was caused by a fungus growth which usually entered at the stem end; that it might be transmitted from diseased oranges to healthy ones by contact or by soaking them in water; that it might be transmitted also by means of pure cultures of the fungus placed on the fruit, or placed in water in which the fruit was soaked; that the fungus could infect the fruit through a stem left on an orange at least 3 inches long; that fruits could be infected by placing them in water with soil from under infected trees; that it took from one to three weeks after infection, for symptoms of the decay to appear.

During the past year additional information and facts in regard to the disease have been obtained by observation and spraying experiments in various orange groves in the state, and by experiment and study in the laboratory. I will not give you the tiresome details of these, but speak of the facts brought out.

[fol. 287] First of all there is one correction to make. I said last year that the fungus was a species of Achlya belonging to the water moulds. Further study has shown that it is not a water mould, but probably some higher form.

Inoculation Experiments

In my paper last year I showed some charts containing the tabulated results of the work to that time. In order to definitely establish these results and find out further in regard to the fungus, some additional experiments were carried out last November and December. We wished to find out (1) the influence that injury to the rind would have on making the fruit subject to stem-end rot decay. For this purpose the rinds of some oranges were slightly cut near the stem end like a bad clipper cut, while others were left uninjured and comparison sets were made, placing on these both fungus filaments and the fungus spores. A comparison was also made as between the effect of stem end

rot fungus, and the known citrus disease fungi, when placed on the surface of the fruit. Both sound and clipper-cut fruit were used as before. The results are shown in Table I.

Table I.

Stem-end Rot Infection on Oranges

Experiment No.		Total stem-end decay in 5 days Per cent	18 days Per cent	23 days Per cent
1.	Fungus filaments put on stem end	22	66	100
2.	Fungus filaments put on clipper-cut rind	100	100	100
3.	Spores of fungus put on stem end	.00	.00	100
4.	Spores of fungus put on slipper-cut rind	.00	100	100
5.	No fungus put on stem end	.00	.00	.00
6.	No fungus put on clipper-cut rind	.00	.00	.00
7.	Withertip fungus put on stem end	.00	.00	.00
8.	Withertip fungus put on clipper cuts	.00	.00	.00
9.	Scaly bark fungus put on stem end	.00	.00	.00
10.	Scaly bark fungus put on clipper cuts	.00	.00	.00
11.	Gummosis (Diplodia) fungus put on stem end	.00	60	80
12.	Gummosis (Diplodia) fungus put on clipper cuts	100	100	100

[fol. 288]. (2) We wished to find out how readily fruit, lying on the soil in which there was stem-end rot fungus, would be infected. For this purpose 5 wooden boxes containing soil were prepared as follows: (a) Soil from under an infected tree, (b) soil from Experiment Station grounds in which no citrus trees had been growing, same source sterilized and treated by mixing in cultures of stem-end rot fungus. Sound fruits were then placed stems down in the soil, and it was kept moist. (See Table II.)

Table II.

Stem-end Rot Infection on Oranges

Fruit Placed Stems Down on Soil

Experiment No.		Total stem-end decay after 5 days Per cent	13 days Per cent	22 days Per cent	31 days Per cent
1.	From under infected trees, Ormond, Fla.	.00	.00	10	20
2.	From Florida Experiment Station Grounds	.00	.00	.00	.00
3.	From Florida Experiment Station Grounds, plus fungus	.00	.00	2.5	5
4.	From Florida Experiment Station Grounds, sterilized	.00	.00	.00	.00
5.	From Fla. Exp. Sta. Grounds, sterilized, plus fungus	.00	5	26	42
6.	Check, fruit protected from soil	.00	.00	.00	.00

The results of these experiments show that this fungus unlike the blue mold can enter without injury, but is favored by injury; that the time for decay, from the (c) soil from Experiment Station grounds in which cultures of fungus had been mixed, (d) soil from the same source sterilized, and (e) soil from the introduction of spores is greater than when filaments of the fungus are introduced, and that withertip and scaly bark fungus cannot produce stem end decay, but that the gummosis fungus (Diplodia) of which more will be said later is also able to produce a kind of stem end decay.

Other new facts brought out by our study since last year are these: That the fungus lives and produces spores in the dead twigs and in and on the decayed fruit, that it is [fol. 289] more widely distributed than it was first thought to be.

We also tried out some spraying experiments beginning in October in five different parts of the state. In the first plot Bordeaux mixture was used; in the second ammoniacal copper carbonate; in the third self-boiled lime sulphur and in the fourth the commercial lime sulphur. The reports of shipping experiments have just come in, and it seems that the spraying had very little effect upon the amount of stem end decay on fruit held at Washington for as long as three weeks. The checks were nearly as good as any of the others. This shows that spraying with fungicide for stem end rot decay is no good whatsoever, especially if begun as late as October. The checks were 21% after three weeks at Washington, Bordeaux was 32% (11% more), ammoniacal copper carbonate was 21%, just the same as the check; self-boiled lime sulphur, 23%; commercial lime sulphur, 17%, somewhat less, but not greatly less than the check.

These shipping tests were made by H. J. Ramsey of the Bureau of Plant Industry.

Control

The results of this study and experiments with this fungus indicate rather definite lines of control. Since the spores of the fungus are abundant upon the killed twigs and mummified fruit upon the ground, the importance of a thorough pruning out of these dead branches and a thorough cleaning up and burning of diseased fruit that have dropped

the previous year is suggested as a means towards preventing new infection of the next crop.

The result of the inoculation experiments last year suggested the probability of fruit becoming infected when being washed, and the advisability of trying experiments in treating the wash water and also in spraying the oranges with a fungicide just as they came out of the tank. In cooperation with Mr. Ramsey of the Bureau of Plant Industry, Washington, we carried on some experiments in this line at two different packing houses. It may be said as a [fol. 290] general statement that these experiments did not indicate that any new infection tok place in the short time that the fruit was in the wash water. Our experiments at least, did not show any consistent difference in amount of stem end decay between the treated and the untreated fruits. Some of the chemicals we used appeared to increase the amount of blue mould decay due probably to injury to the rind.

Gummosis

A second fungus enemy has been found guilty only during the last ten months in connection with the gumming of both orange and peach trees. The gumming of orange and peach trees in various forms has been known for a good many years. There are several diseases in which gumming occurs, but the word "gummosis" in Florida has been applied to the particular disease of citrus trees in which the first stages are characterized by copious flow of gum from breaks in the bark on the trunk or large limbs some distance from the ground, and in the later stages by a shagginess of the bark. Only recently has it been known that there was any fungus in connection with this trouble and it has been attributed to various causes, such as cold, the wrong kind of fertilizers, borers and the like. And while one or more of these factors may weaken or injure the tree so that the fungus may more easily enter, it now seems probable that this organism is one of the agents in causing one form of disease known as gummosis.

Description

The disease first makes itself apparent on citrus trees by the oozing out of a thin watery gum, which sometimes runs

down the bark in lines, forming what is known as "tears." Later the gum thickens and collects in large quantities at the cracked places in the bark. As the disease progresses, the bark cracks still more and assumes a shaggy ulcerated appearance over patches three inches to a foot or more in length. The diseased patches may extend entirely around the limb or may be confined to one side of the branch. The gum seems to exude most during the growing period in the [fol. 291] spring and summer, and sometimes entirely ceases in the fall and winter. In cases where the gummosis is not too severe, new bark is formed under the old and the surface becomes marked by ridges, warts and resinous-looking deposits and at the edge of the diseased area are large bits of bark which have been pushed up and are hanging by one edge. When the disease is of some age, it may easily be mistaken for the true scaly bark.

A species of fungus belonging to the genus Diplodia (Diplodia natalensis) has been found under the bark of diseased patches on citrus trees and the same fungus has been found in connection with diseased limbs on gumming peach trees. It was first obtained from the interior of gumming peach branches by E. W. Berger of the experiment station in July of last year and was afterwards isolated by him from gumming peach branches from five different counties in the state. The two most widely separated localities were West Tampa and Pensacola.

In September of the same year, what appeared to be the same fungus was obtained from the gumming orange limbs and afterwards obtained from six different counties of the state. Both peach and orange trees in the greenhouse were inoculated by taking bits of this fungus which had been grown in the laboratory and inserting it under the bark. In each case, the bark of healthy trees was cut in exactly the same way. These peach and orange trees in which the fungus had been inserted under the bark gummed copiously, very much in the same manner as they do when infected in the orchard; while those which had been cut in the same way but no fungus inserted, healed up without gumming in any case. This seems to show that this particular fungus may be one of the agents at least in inducing the gum and it is probable that in many cases some slight injury allows the fungus to get in. This is not thought to be true in all cases, as the following will indicate:

[fol. 292] Some inoculations were made by placing the fungus on the surface of the bark of peach trees without cutting or injuring it in any way. Where the bark was young and green, gumming took place, while in cases where the bark was thicker and harder, no gumming was seen.

Another interesting discovery was made while working with this fungus. It was found as stated before, that this fungus could also cause stem end decay of fruits. The

Table III

Gummosis Fungus Infection on Oranges

Experiment No.		Total stem-end decay after 15 days Per cent	18 days Per cent	25 days Per cent
1.	Soaked in water with fungus 24 hours.....	.00	15	50
2.	Soaked in water without fungus 24 hours..	.00	.00	.00
3.	Fungus filaments put on stem end.....	.00	60	80
4.	Fungus filaments put on clipper cuts.....	100	100	100
5.	Check. No fungus put on stem end.....	.00	.00	.00

decay is so similar to the true stem-end rot decay, that even an expert could not tell it at its early stages. As the decay from the gummosis fungus proceeds, however, the fruit becomes light in weight, with black streaks and is not so soft and mushy as in the other decay. Table III. shows the results of experiments with the gummosis fungus.

These results seem to show that sound oranges are not so readily attacked by the Diplodia fungus as by the true stem-end rot fungus, but that injured oranges are just as readily attacked and more quickly destroyed. I do not think this fungus could enter a sound orange while still on the tree.

The facts brought out in relation to gummosis are that there is a species of fungus connected with it; that this fungus can be grown on pure culture and on being inserted into the bark of healthy orange and peach trees will cause copious gumming; and that the same fungus when placed on oranges is able to cause a form of decay resembling stem-end rot.

[fol. 293] Control

The line of treatment for gummosis at once suggested by this discovery is to get rid of the organism in the infected

tissue. If the disease has progressed until a good portion of the bark around a tree is involved, it might as well be cut out and burned. If it is not far advanced, the tree or limb affected can probably be saved by the following treatment. The finding of this fungus growing in the diseased places would indicate that the severe cutting away of all diseased tissue should be employed in order to get rid entirely of this fungus. Some growers have been using with apparent success the method of cutting away quite severely, and where there are decayed places cutting these out further with a sharp knife or chisel. These cut surfaces are then disinfected and the whole surface covered with a kind of grafting wax. A very good wax for this purpose which has been used with good success by Mr. Hart of Hawks Park for cut surfaces, is made as follows: 6 ounces alcohol, 1 pound rosin, 2 ounces tallow, 1 ounce spirits of turpentine. Mix the tallow and rosin and heat together. Take off and cool and turn alcohol in slowly. Last put in the turpentine.

In conclusion it may be said that prevention rather than cure is what we should strive for in the future, and even after the disease is present, the pruning knife and the saw are of first importance and the once "cure all" method of spraying should be used with care. For orange trees at least, it seems to me that spraying with fungicides in our present state of information should not be depended upon and should be looked on rather as a temporary means of relief in some severe cases of disease. In the treatment of these troubles, it is necessary, as has been stated before to know all the different agents both fungous and insect that are working in an orange tree; and to adopt the method that will be best fitted when one considers the effect of this treatment on all of them taken together.

[fol. 294] Discussion

Prof. Hume: In connection with this report we have two other speakers, but I believe it would be a good idea to have at least part of the discussion now.

I might say in this discussion that Prof. Fawcett is a very modest man. He has worked out and put before you today, a problem which has puzzled the best investigators in this country, both in the peach growing districts and in California, and it has come off just as plain as the rule of

two and two are four. But I think you ought to know the study and observation and investigation which has made his talk possible.

Mr. Gillette: Prof. Fawcett stated to us that he thought in the early stages of this disease (gummosis), it might be controlled. I would like to ask him by what method or what means it can be controlled, and what he has found most successful.

Prof. Fawcett: I have had very little experience myself in treating it the way I would treat it since this recent discovery. The method as employed was to take off the loose bark and paint with Carbolineum. The results were not as satisfactory as we wished; although it seemed to help it, it did not cure the trouble. Mr. Stevens of DeLand, has cured a number of cases by cutting back, in the early stages, into the live wood both ways from the point of infection and, in some cases, putting grafting wax over it.

Mr. Gillette: What was the disinfectant used?

Prof. Fawcett: I think he used Carbolineum. But some caution must be used in using Carbolineum, because if you get it too strong, it might do much harm. I advocate a more mild disinfectant, such as Bordeaux, or a paste of lime and sulphur. Of course, you can weaken Carbolineum with soap and water.

Mr. Gillette: The Professor's experience coincides with mine, exactly. I presume I have had more experience with gummosis than almost anyone here, for the reason that I had charge of a large grove in Cuba. You never have seen gummosis in Florida that compares with that they have in [fol. 295] Cuba. In a grove of probably 150,000 trees in Cuba, I presume 60 or 70 per cent of them have been attacked with gummosis. At the time I saw it, it resembled foot rot, although in the wrong place. I thought it was foot rot. The trees were infected just a little above the ground. I soon found that I knew nothing about it. They thought that my coming from Florida, of course I would know just how to cure it, but I have to confess that it was something new to me. In one of the groves they had a good deal of trouble with lemon trees largely on account of this trouble with gummosis. Several experts visited Cuba, and some of them claimed that the trouble was with the roots. I did not believe that.

When the disease started, we cut it back just as the Professor says, into the clean wood. We scraped it, and treated it with Carbolineum, but soon found that it burned the trees. We weakened it, and found it worked better. Some of the trees, however, died, and we concluded to burn them. We had the trees cut off, and new shoots came up, and some of the finest trees grew from those old roots.

The disease never started on those trees until about the second or third year; that seems to be the time when the disease begins to develop. At first, I thought it was brought about by something the trees had taken up from the soil.

In the first grove of one hundred acres, I never saw trees grow more beautifully than they did for two years. Then, after a wet season, the disease broke out all through the grove. Out of 8,000 trees, about 7,000 were affected. It seems as though the extreme moisture had made soluble in the soil something which the tree had taken up to excess. The tree was just like a person whose blood is bad and boils had broken out. We began treating them just as the Professor stated, by cutting out, cleaning away and using several insecticides. Some trees were healed up in a short time, and some of them seemed to entirely recover. But we soon [fol. 296] found out that if the knife used in scraping the trees was not absolutely clean, it would inoculate another tree, so we had to put the blade into the fire and burn it after treating every diseased tree, to keep from carrying the disease all through the grove.

I was on the Isle of Pines about three weeks ago. I went into one of the largest groves on the Island. It is a handsome grove, but all through it I noticed vacant spots, and in walking through I noticed trees with great sores on the side, some of them healed and some of them bleeding badly from the disease. It seems to me that unless they do something very soon, they are going to lose a very valuable piece of property. As I stated before, the disease is much more prevalent there, and works much more rapidly.

This disease seems to be more prevalent in the hammocks and in the lower lands, like those on the Manatee River. They seem to have considerable trouble there. I know several people in that section who are troubled with it, and they are going to lose their groves if drastic measures are not taken.

In nursery work, we very frequently begin budding, say in July or August. This is something we ought not to do. Very frequently you will find a whole lot of those trees will gum, in a manner very similar to gummosis, although I do not think it is the same thing. I was once very much alarmed, for the reason that gummosis seemed to have gotten my nursery, but it soon healed over and there was no harm done.

Prof. Rolfs: I know there is no one here who can appreciate the amount of work Prof. Fawcett had to do to come to this scientific conclusion. However, there is no one here who undervalues the conclusion he has come to. He has proved it is due to a specific agent he has discovered. I think Prof. Fawcett is on good, solid ground to getting a practical and profitable remedy which heretofore we could not have gotten without great expenditures of money, and then only in an approximate way. The knowledge of this [fol. 297] disease has been carried to this point; now he is ready to go ahead with the practical side of it and find out what is the best remedy.

I merely wished to call attention to this, Mr. Chairman, that the talk consumed only a few minutes, while it took nearly twelve months to give him the knowledge to make that talk. In a few minutes he told you what he had discovered about gummosis of the peach, but he did not tell you that it has baffled the scientists from California to New York and south to Florida, and this is the first time it has been definitely proven what the agent is.

Dr. Richardson: A line of thought has been suggested to me by a remark dropped by Mr. Gillette. You remember that he said that it was something like a man with impure blood that broke out in boils. Having practiced medicine for thirty years, and having treated people for boils, I want to say that we know, now, that impure blood is not the cause of boils. We know that boils are caused by microbes that come from without.

It occurs to me that this is true in every one of these diseases we have been discussing, of citrus and other fruit trees. They have not come up from the soil. The disease has come into the tree from other sources; in Mr. Gillette's experience, the inoculated knife. The old-time surgeon used to introduce more diseases than he cured by the use of his infected hands and unclean instruments.

A short time ago, I was advised by self-proclaimed experts to treat my trees with remedies applied to the soil. I know better, now. If you stop to think a moment, you will know that these things do not go that way. The best of all germicides, the most potent, and the cheapest, is God's sunlight. Sunlight destroys more germs than anything else. Next comes water. Water, and then the best known germicide is pure, dry earth. These three are the strongest combination of germ-killers known.

One of the first things a grower should do, is to protect his trees by means of proper cultivation of the soil. Keep [fol. 298] it clean. Keep the soil stirred up so that the other two agents may get at it. Let the sun and the water and the dry earth come to the relief of the diseased tree, and they will do more than anything else I know of. The sanitarian today is a successful practitioner, and the sanitary grower is the most successful in treating the diseases we have been discussing. Prevention is better than cure, any time. Keep the germs away from your fruit and it will carry to market without rotting. If you can keep away from your pruning shears and budding knife, the germs that are teeming in millions, you will have cleaner and better stock. Don't look in the wrong place. Keep things clean, keep your soil stirred, and give Nature a chance to do better work.

Mr. Gillette: These discussions are always productive of results. We have found out something about boils. It has always been a question, it seems to me, since the dark ages, where is the best place to have boils. We have found out that we can pick the place, and all we have to do is to light on the right spot and make them come there.

Now, there is no question but that sanitation, applied by a physician, is a wonderful cure for diseases that flesh is heir to, but I am not so sure about it when applied to an orange tree. This question of orange growing is one which stumps us all. The Doctor has advised us to open up the soil and let in the air and water and sunshine. On the other hand, go into the dense hammocks where the orange trees grow naturally and you will find no sunshine, and it seems to me the trees are in a more perfect condition than where they are cultivated.

I have found in every neighborhood, at least one man who insists on clean cultivation. He grows oranges, too,

and fine ones. His next door neighbor believes in cover crops and keeps the ground well protected from the sun, and he grows oranges, just as fine as the clean cultivation man. Another man goes still further and believes in let- [fol. 299] ting the weeds have entire possession of his grove, and he succeeds, too. How these different methods all succeed stumps us, but they do.

Mr. Connora: In Professor Fawcett's paper he has a statement in relation to pruning the trees for stem-end rot. It seems to me this is a matter of rather grave importance to the growers who have stem-end rot in their groves, to know at what time the trees should be pruned with good results. Now, pruning out the dead wood when the trees is full of fruit would not be a good thing for the tree. I would like to have the Professor state, for the information of all of us, what he thinks to be the best time of the year to prune for stem end rot. I am looking for all the help I can get from people who know more about it than I do.

Prof. Fawcett: The wither-tip fungus is in almost every grove in the state. Prof. Rolfs' experiments some years ago, showed very plainly that there were two periods of the year when pruning can be most safely carried on. Those two times are in the dormant season in December and January and again in July, when the first growth of wood has somewhat hardened; and so I would say that for stem-end rot, also, we should, if possible, choose those periods so that we will not have a possibility of withertip infection. If you prune for withertip when the new growth is putting out vigorously, you are liable to have some trouble with infection in this new growth.

I would say right here that December and January for some of you who hold your fruit on the trees, would be a bad time. July would be a better time.

Professor Rolfs can probably tell us more about it than anybody here.

Prof. Rolfs: While I was carrying on the work on withertip, we found that January was the most effective and advantageous time. Next to that, July. When we pruned in the early part of the year, and after the tender growth had hardened, it frequently occurred that it did more harm than good. Pruning was carried on successively through the [fol. 300] entire twelve months to establish the fact as to

when we should prune for wither-tip, and the effect on the trees was much better when they were pruned in January and July than at any other time. Just why that should occur, we did not attempt to answer, as we were after results at that time, not after the theoretical information.

As to whether we shall prune at the same time for stem-end rot will depend upon further investigations that Prof. Fawcett is making of the life history of this fungus. If infection of the fruit takes place at a different time of the year than when these prunings occur, it may be necessary to prune a little earlier or a little later, according as to what the further line of investigation may develop.

I think we are particularly fortunate in having Prof. Fawcett report these things to us year after year, to keep us in close touch and observation. You will see from the information you get on stem-end rot and on this gummosis, that Professor Fawcett has given us all he has in his shop, and we will have to be satisfied with that. During this coming year, he will accumulate some information and give it to us then if we want it, and I think we all want it.

Mr. Thompson: Professor Fawcett spoke of sterilizing the soil under the tree for stem-end rot. How is it done?

Prof. Fawcett: That was a small amount of soil for the experiment, and it was done by heating it up to 350 degrees. Of course, that was a small amount of soil and this method would be impracticable for general use.

Mr. Gillette: Have you discovered stem-end rot in green oranges.

Prof. Fawcett: Yes, it occurs when the oranges or grapefruit are just beginning to color and once in a while, before then. But it takes a different form. It discolors it when the oranges are green, but when the oranges are mature, it infects with scarcely a discoloration at first.

[fol. 301] PLAINTIFF'S EXHIBIT No. 16

Executive Committee: C. C. Chapman, President; Harry B. Chase, Vice Pres.; A. F. Call, W. G. Fraser, F. Q. Story, A. Gregory, E. S. Moulton, W. E. Sprott, C. C. Teague.

Citrus Protective League of California, 742 Consolidated Realty Bldg.

First National Bank, Treasurer; G. Harold Powell, Secretary and Manager

The Decay in Citrus Fruits While in Transit

Los Angeles, Cal., February 4, 1911.

To the Citrus Fruit Growers of California:

After the 1st of February the decay in citrus fruits while in transit is likely to increase. The fruit is riper, more tender and therefore more susceptible to injury; the weather is warmer and for a time may be more humid, and as the shipments during February, March and April become heavier, the work in the groves and packing houses is forced to the limit, and unless systematically checked is likely to be carelessly done. A sound orange with an uninjured skin does not decay; bruised oranges are almost sure to rot, under the conditions outlined. This is the time of year when every organization, every grower and every shipper ought to stop and look into its own operations to see whether the fruit is handled with enough care to prevent injury and decay.

A sound orange not only ships in sound condition, under any method of transportation, but it remains sound in the hands of the jobber, the retailer and the consumer. A bruised orange may be transported in sound condition if it is iced or precooled quickly after picking, but it is likely [fol. 302] to rot as soon as it leaves the car and becomes warm and moist enough for the decay to develop.

The careful handling of the California orange and lemon crop is a business question. There is enough involved in it to cause every grower and shipper to give it serious consideration. Formerly, the loss from decay in transit was estimated to vary from three-quarters of a million

to a million and a half dollars, annually; it is much less now. This money, in addition to the freight paid on the rotten fruit, has been practically thrown away. It can be added to the earnings of the citrus fruit grower, as the most common losses from decay are preventable by the careful handling of the fruit.

The decay question has been investigated by the United States Department of Agriculture for several years and many of the growers and shippers understand it. Many of them do not. There are others who understand, but who do not practice the teachings of the Department. The principles underlying the decays in citrus fruits are therefore restated.

The most common decay in citrus fruits while in transit is caused by blue mold, a low form of plant life, which cannot grow through the healthy, vigorous epidermis of the skin. It belongs to a class of organisms which grow on dead or weakened tissues. Blue mold on the skin of a vigorous, sound orange is in the same condition as barley would be if sown on an asphalt pavement; neither can penetrate the tissues or the soil beneath. They are similar also in that neither can grow in a good soil without heat and moisture to germinate them. The blue mold, though, will grow slowly at a temperature as low as 32 degrees Fahr., though its development is greatly retarded in a temperature of 40 degrees Fahr.

Practically all the decay in transit is the result of bruising and injurying the fruit during its preparation for shipment. Clipper cuts, stem and gravel punctures, finger nail scratches and rough handling in the packing houses—these are the most common forms of injury.

[fol. 303] The Federal Department of Agriculture has spent thousands of dollars in co-operating with the citrus industry in establishing the principles of good fruit handling. It has shown that the lemon and the orange will keep for months and can be shipped in sound condition if the fruit is handled properly during its preparation for shipment; but the Government can never do for the grower and the shipper those fundamental operations which they only can perform. It has helped to point out the causes of decay. It remains for the industry to handle its opera-

tions in such manner as to make the findings of the Government effective.

The control of the decay is a business proposition. It is practical to control it, but it is not an easy question to handle. It is not self-regulating. It is related to the methods of paying labor, the methods of fruit picking, and to all of the business practices that surround the handling of the fruit. Any system of labor handling or of business management that places a premium on the quantity, rather than the quality of work performed, is likely to lead to decay. The careful handling of the fruit is unusual, unless the grower, the organization, or the shipper has provided some method of enforcing it. It must be the business of someone to see that careful handling methods are habitually practiced. In the end it depends on the man who handles the labor and he must have the strong support of those who employ him, or decay cannot be escaped.

The effect of bad handling on an orange or lemon is often difficult to see, and those who are not used to looking for small mechanical injuries are likely to overlook them. A pair of sharp eyes, however, will find most of the trouble; and the largest amount of injury is often found in the fruit of the grower who performs all of the other operations of the grove with scrupulous care, but who allows the handling of the fruit to regulate itself.

Now is the time to stop and see where you stand. Your oranges are as likely to be in the crippled and injured class as those of your neighbor. Unless your whole sys- [fol. 304] tem of business places a premium on the care with which the work is done, the chances are more than even that you will find from 10 to 40 per cent of your fruit injured in the various operations of handling.

The Citrus Protective League stands squarely for the conservation of the earnings of the citrus fruit grower. It does not believe that the citrus industry can afford to lose a million dollars a year from decay, or any considerable proportion of that amount. It knows that the principal losses from decay are avoidable. Every grower and shipper is therefore urged to consider this question now, before the favorable season for decay sets in. Standardize your picking so that all of it is done with care. Make it someone's business to enforce careful handling. Be careful of the picker who is paid by the box. Look out for the

man who picks over fifty boxes a day. Be careful of the loading, the hauling and of every operation in the packing house, from the unloading of the fruit to the final loading in the car. Watch the fruit of each grower where it is pooled through an association. The oranges of one may show two per cent of injury, while the fruit of another shows forty per cent. See that the points of the clippers are round, instead of pointed. Watch the emptying of the fruit from the sacks. See that the grove is fumigated next year, if the oranges have to be washed. Sound fruit is the price of eternal vigilance, but every grower and every shipper can have it if he will devote as much attention to it as he does to the culture or selling of the crop. In short, study your whole system of doing business and determine the relation of each operation to the care with which the fruit is handled. A system that insures careful handling leads to better work in every department of the citrus fruit industry. You are urged to take this matter up with your labor, your association, your directors, your shipper, or with anyone in authority, and give it critical attention from now on.

G. Harold Powell, Secretary and Manager.

[fol. 305] PLAINTIFF'S EXHIBIT No. 17

Circular No. 2

Executive Committee: C. C. Chapman, President; Harry B. Chase, Vice Pres.; A. F. Call, W. G. Fraser, F. Q. Story, A. Gregory, E. S. Moulton, W. E. Sprott, C. C. Teague.

Citrus Protective League of California, 742 Consolidated Realty Bldg.

First National Bank, Treasurer; G. Harold Powell, Secretary and Manager

The Prevention of Decay in Citrus Fruits

Los Angeles, Cal., Feb. 18, 1911.

There appears to be more decay in oranges in transit this year than usual. This condition seems to be due to

a number of factors. The crop is larger than ever before and the labor is pushed to the limit in the groves and packing houses. We have records of pickers who are averaging from 150 to 200 loose boxes a day, and every inducement is held out to them to increase their output. We find that many houses are washing more fruit than usual. The worst cases are in these houses. We have records of fruit that is supposed to be handled carefully, that show from 20 to 50 per cent of mechanical injury. The decay develops as a result of the handling of the fruit after it leaves the tree. It does not decay while it is hanging on the tree. A few oranges that have been punctured by insects, or that are affected with black rot, or are injured in other ways, may rot before they are picked.

While the mechanical injuries caused by the handling of the fruit, the washing, the pressure of the cover on the [fol. 306] high packs and other things that can easily be seen account for most of the decay this year, they do not appear to account for all of it. There seems to be a large amount of physical injury to the navel end of the orange, caused by the conditions of growth and by the black rot. These conditions make the fruit unusually susceptible to improper handling and easily infected with blue mold. It requires unusual care in handling and unusual sanitary precautions to prevent decay this year.

The Relation of Black Rot to Blue Mold Decay in Oranges

Nearly twenty years ago Mr. N. B. Pierce, of Santa Ana, who was then connected with the United States Department of Agriculture, investigated the nature of black rot in oranges. This disease is unusually severe this season. It is caused by a fungus belonging to the genus Macrosporium. Mr. Pierce found that this fungus gains entrance to the fruit through splits and imperfections in the navel while the fruit is immature and hanging on the tree. The injuries to the navel which appear to be caused by the condition of growth, may be too small to be seen with the naked eye and may not occur in the exposed parts of the navel. Mr. Pierce found that these spores or seeds of black rot, like those of blue mold, cannot enter the healthy, unbroken skin of the fruit. It is probable that it gains entrance to the orange in the fall, when it is immature,

and that the first fall rains or heavy dews cause the spores to germinate and enter those fruits in which the tissues of the navel have been split apart or weakened in growing. It was found by Mr. Pierce that from 10 to 60 per cent of the oranges that dropped from the trees in 1892 as late as March 1st were affected with this trouble. He found also that from 1 to 5 per cent of the entire crop was so affected in the sections in which he worked.

The oranges that are effected with black rot ripen prematurely and can be detected early in the season by their high color, but as the season progresses this distinguishing mark is lost and the affected fruit is packed for shipment.

[fol. 307] We do not know the conditions of climate, of soil-treatment and of other cultural handling that cause the navel-end of the orange to split.

Nothing can be done at this time of the year to prevent the damage caused by black rot. We do not know that it can be controlled in the fall, but it has been suggested by Mr. Pierce that experiments be tried with dry lime and copper sulphate before and after the fall rains. Bordeaux mixture or some of the sulphur remedies might be effective. It might also help in reducing the disease to pick the oranges from the ground and destroy them. It is not enough to plow them under.

There is a direct connection between black rot and the amount of blue mold decay in transit. The black rot breaks down the tissue of the fruit and acts as a mechanical injury in so far as its susceptibility to blue mold is concerned. Therefore, many of the oranges affected with black rot become affected with blue mold while the fruit is hanging on the tree or while it is in transit. These oranges are particularly susceptible to rough handling as the tissues have already been weakened. It is probable also that whenever the conditions of growth cause the navel to split in the fall, this part of the orange remains weak and is unusually susceptible to rough handling. Therefore, in a season like the present one, it is doubly important that fruit be handled with unusual care to prevent injury to the navel and also that every precaution be used to lessen the chances of infection.

The Influence of the Packinghouse Manager on Decay

No one set of men in the citrus industry can exercise a greater influence on the decay question than the packing house managers. They are in constant touch with the growers; they often control the harvesting; they can regulate the handling of the fruit in the packing house and can absolutely control the sanitary conditions in the house.

[fol. 308] The Prevalence of Rot Depends on the Amount of Decayed Fruit in the House

The infection of the fruit by blue mold depends largely on the prevalence of decayed fruit in or near the house. This matter can be regulated by the packing house manager. If there are 1000 injured oranges in the house and only one blue mold spore, there is but one chance of infection. If there are 1000 spores in the house the chances are multiplied a thousand times. The packing house manager can reduce the chances of infection by enforcing a few simple sanitary precautions. A prominent association manager who has had years of experience in the technical handling of the decay question recently said that 75 per cent of the decay can be eliminated by keeping the decayed fruit out of the house and by a rigid practice of cleanliness in every operation.

Suggestions to Packinghouse Managers

The following suggestions are offered to the packing house managers. Their hearty co-operation is asked in putting these suggestions into practice. It is a business question and affects the interest of every fruit grower vitally:

Do not allow decayed oranges to accumulate under the brusher, the bins, or hoppers, or around any part of the machinery, or in any part of the house. Sweep the house clean every day, wash the machinery frequently and destroy every orange that is not fit to ship.

Do not allow decayed oranges or lemons to enter the washing machine, the brusher, or any part of the machinery. This happens frequently in many houses, and one decayed orange passing through the machine infects it and spreads the disease.

Do not brush the fruit if it is already clean. The brush is a most effective way of spreading disease. The bristles carry the spores into the mechanical injuries of the fruit.

Do not wash the fruit unless it is smutty. Segregate the clean fruit and wash only that which actually requires it. There is no more effective method of spreading blue [fol. 309] mold than the washing machine, especially the old tank type of washer. The water furnishes ideal conditions for the growth of the disease. This is especially true of navel oranges. The water accumulates and is held in the folds of the navel.

Do not try to disinfect the water for blue mold. This disease cannot be killed by any strength of copper sulphate or permanganate of potash that would not be injurious to the fruit.

Do not place boxes of decayed fruit on the windward side of the house, or have the cull pile near the house. Clouds of spores are carried in with every gust of wind. They settle on the machinery, on the fruit, in the bins and boxes, and increase the chances of infection.

Do not handle decayed fruit with gloves and afterward handle the sound fruit with the same gloves. No surer methods of infection could be adopted.

Do not keep the decayed fruit in boxes that are afterward to be used in the grove. Provide special boxes, mark them and use them for nothing else.

Do not allow the hucksters to sort over cull fruit that contains decayed oranges or lemons, unless the cull pile is removed some distance from the house; the spores rise in innumerable numbers in handling the rotten fruit.

Do not fail to wash the picking boxes, if decay starts while the fruit is in them. This applies also to lemon trays. It is a wise precaution to line the bottom of lemon trays with paper. It reduces the injury to the fruit and makes it easier to keep the trays clean.

Do not fail to line the rot boxes with paper in such a way that the paper may be folded over the boxes when full. This will prevent the spread of an enormous number of spores.

Do not allow the graders to throw decayed fruit in the rot boxes. Have it placed in them carefully. The spores

from a single rotten orange or lemon thrown into a rot box spread throughout the house.

[fol. 310] In cleaning lemons which have been next to decayed fruit, use a damp sponge to prevent the spores from flying through the house. Clean the sponge frequently.

Do not let up on the campaign for careful handling. It was never needed more than in the present year.

These suggestions are made to supplement the careful handling of the fruit and not to take the place of it. They apply to the citrus industry some of the simple fundamental precautions that are in every day use in preventing the spread of human disease.

Do not forget that the cleanliness and neatness of the packing house is an infallible indication of the care with which all the fruit handling operations are carried out.

G. Harold Powell, Secretary and Manager.

PLAINTIFF'S EXHIBIT No. 18

B. P. I.—676. Issued July 13, 1911

United States Department of Agriculture, Bureau of Plant Industry, Washington, D. C.

Field Investigations in Pomology

The Relation of Handling to Decay in California Navel Oranges, Season of 1910-11

Introduction

During the shipping season of 1910-11 there has been considerably greater loss from blue-mold decay in Washington navel oranges in transit from California to eastern markets than has prevailed for four or five years. Following the work of the Bureau of Plant Industry in investigating the causes of decay in California oranges begun by Mr. G. Harold Powell in 1904 and continued [fol. 311] through five successive seasons, there was a very general improvement in the system of handling and marketing citrus fruits in California, and the losses from de-

cay were effectively checked or reduced to a negligible minimum. During the early part of the present season, however, many shipments of navel oranges from California showed heavy decay from blue mold, and the conditions which were responsible for this seemed to be due to a number of factors acting singly or in combination.

The season was an unusual one in many respects. The crop was the largest in the history of the industry; the season was most unfavorable for handling, frequent rains interrupting picking operations and making ideal conditions for the development of blue mold; thus the labor was pushed to the limit in the groves and in the packing houses. Under these conditions it is not surprising that the standard of handling was lowered; moreover, it is more than probable that the fruit was unusually tender and that it was unable to withstand the kind of handling given under ordinary circumstances.

Early in the season a bulletin was issued by Mr. Powell, now secretary and manager of the Citrus Protective League of California, calling attention to some of the measures which should be observed in preventing decay. In February the league requested the Department of Agriculture to delegate a representative of the staff of the Bureau of Plant Industry to make a detailed study of the handling methods practiced by the growers during the season, with a view to determining the relation between the treatment given the fruit and the occurrence of the decay. The point was made that many of the growers and packing-house managers, while appreciating the importance of careful handling, felt that the trouble was due to causes beyond their control and were inclined to attribute the unusual prevalence of the decay to some new condtions which caused the fruit to be unusually weak. From the beginning it was believed by Mr. Powell and the Bureau of Plant Industry [fol. 312] investigators that there was a combination of factors which brought about the decay, but that the main cause was an unconscious lowering of the standard of handling in consequence of the extra large crop of the season. It was considered advisable to make as thorough a study of the conditions in southern California as was possible under the circumstances, and Mr. C. W. Mann, scientific assistant, then located in the State doing work along other

lines, was detailed to begin the investigation. Later in the season, after the close of the bureau's campaign in Florida, Mr. A. W. McKay and Mr. Burr B. Pratt were sent to southern California. The field work in connection with this investigation has been carried on by these three men. Mr. Powell and Mr. George W. Hosford, the latter formerly associated with the bureau work but now manager of the San Dimas Lemon Association, have given valuable advice and assistance as collaborators.

The work was planned along lines similar to those followed in the earlier investigations of the bureau—a determination of the percentages of mechanical injuries in various packing houses, a study of the relation of these injuries to the occurrence of blue-mold decay, and the investigation of the effect of various house-handling methods, washing, brushing, and packing without any special cleaning treatment, all furnishing data for a comparison of the behavior of fruit very carefully handled by the bureau investigators with the same fruit handled under ordinary commercial conditions.

Occurrence of Mechanical Injuries

A count of mechanically injured fruit in many packing houses showed sufficiently high percentages of injuries to account for the greater part, if not all, of the loss from decay. A very decided increase over recent seasons in the occurrence of mechanically injured fruit was found in most of the packing houses examined; in fact, the increase in percentages of mechanically injured fruit in houses which had been doing good work in previous seasons was surpris- [fol. 313] ing and significant, indicating a serious letting down in the standard of handling. The average injury in the different houses examined ranged from 4.8 per cent to as high as 53.6 per cent. The injuries made by individual pickers were as high as 85 per cent. Most of the injuries consisted of clipper cuts, but there were large numbers of abrasions of various kinds, gravel punctures, scratches, etc.

Loose and projecting nails in the field boxes was found to be a frequent source of injury. In one instance it was found that nearly half of the field boxes in use by a large grower were defective in this respect and were injuring a

large proportion of the fruit. These boxes had been in use during the entire season, and although an inspector was employed who was supposed to look after the careful handling of the fruit, he failed to observe the defective boxes.

The condition of the clippers in use was also found to be the cause of considerable injury. On one large place, which prides itself on its careful handling methods and where a system of inspection has been developed, the clippers were found to be in such condition that it was almost impossible to make a close, smooth cut without injuring the fruit. In this instance continuous sharpening of the clippers had worn them down to sharp points which projected in such a way that the slightest touch slit the skin of the orange, resulting in clipper cuts which, although small and apparently insignificant, were ideal places for the development of blue mold. This fact completely escaped the inspector, who had been in the habit of looking only for ordinary defects. This instance shows the necessity for constant vigilance on the part of inspectors, foremen of picking gangs, and managers of packing houses. It is necessary to be always on the lookout for the unusual and the exceptional, as small details are frequently of the greatest importance. These factors have been so often referred to that further repetition might seem unnecessary, but the experiences and observations of the work of the past season show that they can not be too [fol. 314] strongly emphasized. They are likely to be overlooked unless all concerned with the handling of the fruit are constantly on the alert.

Occurrence of Natural Defects

There were unusually high percentages of naturally defective fruits. Early in the season many oranges were affected with black rot and the proportion of "splits" at the navel end of the fruit was unusually large. There is a direct connection between the occurrence of these defective fruits and blue-mold decay after the fruit is packed. Fruits affected with black rot are weakened and the broken-down tissues become easily infected with blue mold. The "splits" may be considered as being in the same category with mechanical injuries. Many of the "splits" are too small to

be detected in the grading and many affected oranges are packed into the boxes.

The indications are that wither tip (Colletotrichum gloeosporioides) was prevalent in some of the districts. It was impracticable to make systematic determinations or counts of fruits infected with the disease. In some instances the characteristic spots of wither tip developed in the packed fruit and blue mold almost invariably followed.

These disease factors are not mentioned here as explanations of the occurrences of the heavy blue-mold decay during the season of 1910-11; they are cited to indicate that they were not overlooked in outlining the scope of the work.

While a certain proportion of the decay in transit was undoubtedly due to the causes mentioned, which were in a large measure beyond the control of the grower, the picking-gang foreman, and the packing-house manager, the investigations made show that by far the greater proportion of the decay was due to mechanical injuries as a result of poor handling. The data obtained amply demonstrate that even in such unfavorable seasons as the present one oranges can be handled in the grove and the packing house with sufficient care to insure their sound condition on arrival in market. In a season like the one just closing it is doubly [fol. 315] important to handle the fruit with unusual care in order to avoid injury to the tender skin. Special precautions are necessary in unusually unfavorable seasons if a high standard and a reputation for soundness are to be maintained.

Handling and Packing Experiments

Handling and packing experiments designed to make a direct comparison of fruit very carefully handled with the same kind of fruit handled under ordinary commercial conditions were made. In most of these experiments the actual picking, grading, handling, and packing of the fruit were done by the bureau investigators. Some packing of the carefully picked and handled fruit was done by an experienced packer working under the direct supervision of the bureau representatives. A comparison of carefully handled brushed and unbrushed fruit with commercially han-

dled brushed fruit was made, and also a comparison of carefully handled washed fruit with commercially handled washed fruit. The work was carried on in 25 different packing houses, and in all 49 experimental series of fruit were prepared. The data which have been obtained, therefore, cover a wide range of conditions and are sufficiently comprehensive to serve as a safe basis for deduction. In all of the experiments the results were clear cut and consistent throughout and showed a definite relation between the kind of handling given the fruit and the occurrence of decay. The fruit was all packed and held two weeks in the packing houses, and the percentages of decay in the various lots were determined by actual count.

Table I.—Average Percentage of Decay in Carefully Handled and in Commercially Handled Washington Navel Oranges in 1911

Number of experiments	Carefully handled	Per cent.		Commercially handled Per cent.		Per cent.
6	Not brushed or washed	3.35	Brushed	7.50	Brushed	16.20
10	Not brushed or washed	2.75	Washed	9.50	Washed	21.55
17	Not brushed or washed	2.90			Not brushed or washed	10.3

[fol. 316] Table I shows a comparison of the averages of decay found in the same fruit under different methods of handling. Dry brushing increased the decay to more than double that found in the untreated lots, and washing increased it to more than four times as much. The washing and brushing given were the ordinary house treatments; no attempt was made to modify these. Under ordinary commercial handling dry-brushed fruit showed more than four and one-half times the decay found in the untreated carefully handled fruit, and washing increased the decay to nearly eight times as much, while the untreated commercially handled oranges showed a decay five times as great as that found in the carefully handled fruit. The effect of the extra house handling is strikingly apparent, indicating the necessity of keeping the handling methods as simple as possible. Brushing should not be done except when necessary, and washing should be resorted to only when it is unavoid-

able on account of smut. Both the dry brush and the washer are only possible sources of injury, but both are very effective in distributing the infections and inoculating any broken places in the skin. The washer is much more effective in this respect than the dry brush, and the presence of the water acts as an additional agency in spreading the infection.

The greater decay in the commercially handled uncleaned fruit as compared with that carefully handled must be attributed to the kind of handling given the fruit in the grove and the packing house.

Table II.—Average Percentages of Decay in All Brushing and Washing Experiments with Washington Navel Oranges, 1911.

Number of experiments	Carefully handled	Per cent.		Commercially handled	Per cent.
11	Not brushed or washed	2.70	Brushed	7.20	Brushed 13.60
11	Not brushed or washed	3.50	Washed	9.50	Washed 21.50
	Average	3.10		8.35	17.55

[fol. 317] Table II is a summary of all washing and brushing experiments made, including all incomplete series. The averages show the effect of the extra handling when cleaning operations are necessary.

Table III.—Average Percentages of Decay in All Carefully Handled and Commercially Handled Experiments with Washington Navel Oranges, 1911.

Treatment of fruit, if any	Carefully handled	Commercially handled
Brushed	2.7	13.6
Washed	3.5	21.5
Not cleaned	2.3	9.6
Average	2.8	14.9

Table III is really a summary of all of the investigations made and is a fair and direct comparison of the results of careful handling and commercial handling in the various

houses where the work was carried on, the decay in the commercially handled fruit being more than five times greater than that found in the carefully handled lots.

Effect of High Pack

It was thought that the extra high pack made in a number of houses might be doing considerable injury to the unusually tender fruit. A comparison of high packing with the same fruit packed firm but not extra high showed only a slight increase in the decay found in the high pack. The same kind of fruit was used in all these tests, and both carefully handled and commercially handled lots were included. The figures given in Tabe IV are the averages obtained from 10 experiments.

Table IV.—Average Percentages of Decay in Washington Navel Oranges Packed Firm and Those Packed Extra High, 1911.

	Per cent
Carefully picked:	
Careful, firm, medium high pack	2.00
Commercial high pack	3.10
Ordinary commercial pick:	
Regular commercial pack	9.23

[fol. 318] The high-pack experiments, unfortunately, were not made until after the heavy rainy season was passed and it is possible that more decay would have developed in the extra high packs earlier in the season. It is of course possible to carry the high pack to extremes, and where a high pack is made care should be taken to have the fruit firmly placed throughout the box. Injury from pressure against sharp edges and corners must be avoided.

Conclusion

It is not considered necessary to give detailed and individual records. The industry is concerned only with the summaries of the records, as it is only from these that safe and intelligent deductions may be made. An extended discussion of the results is also unnecessary, the earlier work of the Bureau of Plant Industry being familiar to a large majority of the orange growers of southern California, and

the packing-house demonstrations which were made in connection with this later study are amply sufficient to show the fact that even under the unfavorable conditions which prevailed during the season fruit may be handled with sufficient care to insure its sound condition on arrival in market.

The solution of the decay problem as demonstrated by the earlier bureau work was shown to depend upon business methods and organization of the industry. The work of the present season corroborates the results of the earlier work in every respect and indicates that the proper solution of the difficulty rests mainly with the packing-house management.

It may be asserted by some that the standard of work carried on by the bureau field men is impracticable under commercial conditions. This is not true. The nearer the ideal methods of care and management can be approached the more certain will be the results. The industry should always be prepared for the exceptional and the unusual.

For a detailed report of former investigations into the causes of the decay of California navel oranges, the reader [fols. 319 & 320] is referred to Bulletin 123 of the Bureau of Plant Industry, entitled "The Decay of Oranges while in Transit from California." A report upon similar investigations in Florida was published as Circular 19 of the Bureau of Plant Industry, entitled "The Decay of Florida Oranges while in Transit and on the Market."

A. V. Stubenrauch, Expert Acting in Charge of Field Investigations in Pomology.

Approved: B. T. Galloway, Chief of Bureau. July 5, 1911.

[fol. 321] PLAINTIFFS' EXHIBIT No. 19

Bulletin 108, November, 1911

University of Florida

Agricultural Experiment Station

Diseases of Citrus Fruits

By P. H. Rolfs, H. S. Fawcett and B. F. Floyd

FIG. 10.—Grapefruit tree affected with withertip. Anthracnose on dropped fruit.

The publications of this Station will be sent free upon application to the Experiment Station, Gainesville, Florida

Record Co., St. Augustine, Fla.

[Preceding omitted.]

[fol. 322] was noticed biting a fruit on a tree in the greenhouse. The fruit was one and one-half inches in diameter, and the wound made was one-half inch across. The fruit was allowed to develop. When it was almost mature, the fruit was three inches in diameter, and the spot made by the grasshopper was one and one-fourth inches across. The new skin that developed over the wound had become scurfy, making the surface resemble silver scurf. (See Fig. 22.)

An experiment of a similar nature to the grasshopper bite was made by Mr. H. S. Fawcett of this Station in studying the nature of silver scurf. He made a figure 4 on a young fruit by means of pin scratches. He found that the figure increased in size with the development of the fruit, the breadth of the scratches increased and a scurfiness developed in the lines. Thus slight mechanical injuries made on the fruit while small will become conspicuous by the time the fruit attains maturity. Such marks seriously affect the market value of the fruit, causing them to be classed low or as culls.

The fruit is subject to mechanical injury from the time it is picked to the time is reaches the consumer. These wounds are nearly always followed by a rotting of the fruit due to the different molds. (See Blue Mold Rots, in this bulletin.)

Preventive.—The minute injuries made on the fruit during its preparation for market cause the growers a loss of many thousands of dollars every year. It has been demonstrated that these injuries can be avoided. Use gloves on the hands whenever the fruit must be touched. Handle the fruit with the greatest of care. See that all surfaces that touch the fruit are perfectly smooth and that all corners are rounded. The fruit must be handled with as much care as a high explosive.

(See article on "Preparing Citrus Fruits for Market," by W. C. Temple, in the Proceedings of the Florida State Horticultural Society, 1911.)

Blue Mold Rot (Pencillium Italicum and Penicillium Digitatum)

This is the most prevalent kind of rot in citrus fruits of all kinds. It begins as a softening and decay at any point on the rind that has been punctured, scratched, or injured in any way. It almost never appears as long as the rind is perfectly sound and uninjured.

The skin on the softened area becomes extremely soft and weak, and is covered first with a white mold, which later produces a blue-green or olive-green powdery layer of spores, giving off a smoky dust when disturbed.

There are two closely related fungi, either one of which [fol. 323] is able to produce the rot known as "blue mold" of citrus fruits, and quite often the two species are found together in the same decayed fruit. These two forms may be distinguished as follows: (1) Penicillium italicum is blue-green in color; and Penicillium digitatum is olive-green as seen after producing spores. (2) Penicillium italicum produces a patch of blue-green with only a narrow edge of white in the center of a much larger softened area not molded; while Penicillium digitatum produces white surface mold nearly to the extreme edges of the softened area as fast as the decay proceeds, and an olive-green patch begins at the center and enlarges.

Preventive.—Since the blue mold follows injuries to fruits, it may be largely prevented by extreme care in picking, handling and packing.

The wounds through which the blue mold fungus is able to cause decay must be guarded against all along the line, from the time the fruit is being picked until it is loaded into the cars. Clipper cuts, long stems, fingernail scratches, and bruises from pouring into the field boxes, are to be avoided. In hauling, the injuries from splinters and rough edges in the boxes, bruises from the bottom of one box being in contact with the top fruit of the box below, and bruises from the jostling of the fruit over a rough road, or in wagons without springs, should be avoided. At the packing house, the further injuries that may result from rough handling, as careless emptying of the field crate from too great a height, and sharp corners of the machinery in washing, sizing and packing, are to be constantly

guarded against. Poorly constructed washers, sizers and bins in such a position that the fruit is put into too violent motion, are to be avoided. In wrapping and packing, fingernail scratches are to be avoided by wearing gloves. (See Mechanical Injuries.) Not only must the slight injuries to the fruit be guarded against at every turn, but the field boxes, wagons, packing houses, and all machinery should be kept clean and free from contamination with blue mold spores from rotted fruits lying about. Packing houses in which culls or other inferior and worthless fruit are permitted to remain for even a part of a day, are pretty certain to become badly contaminated with blue mold spores. These invisible spores are carried to all parts of the structure by means of the ordinary air currents. Groves in which drops are allowed to remain also become permeated with these spores. Under the conditions which ordinarily prevail, it is almost literally true to say that blue mold spores occur everywhere.

Stem-end Rot (Phomopsis sp.)

Like anthracnose this disease makes its presence evident by an unusual amount of dropping. This rot begins in a circular patch about the stem end. At first the circular area is light brown or very little discolored on mature [fol. 324] fruit, but dark brown to leather colored on immature fruit on the tree. The rind remains fairly firm at first, and the discoloration proceeds slowly from the stem end in a more or less uniform circle, and does not extend in

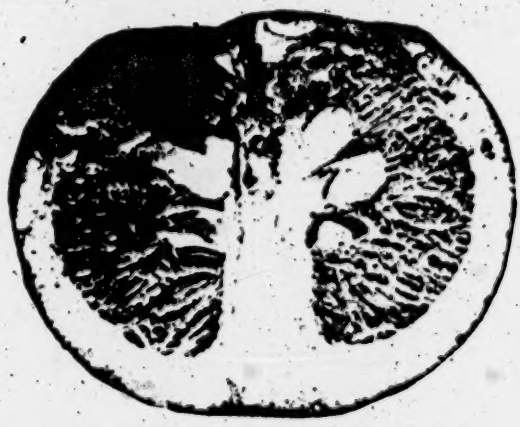


Fig. 23.—Stem-end Rot on grapefruit

bands. (See Fig. 23.) It causes a slow, and at first only slight, discoloration of the center and inner peel and partitions, and the juice sacs often remain unaffected for some time. The fruits, when entirely decayed, still keep their form more or less, but do not turn black until dried up. This rot is caused by a species of fungus hitherto undescribed. It attacks all varieties of citrus fruits, and appears to gain entrance chiefly at the stem end. It is most destructive when accompanied by scale insects under the calyx next to the stem.

Preventive.—The recommendations based on experiment and observation during two seasons may be summarized as follows:

(1) Pruning out and destruction of dead and diseased branches.

(2) The removal and destruction of all dropped and decayed fruits.

(3) Care at all stages of picking and handling to avoid infection from the fungus.

(4) Keeping fruit at low temperature in transit and in storage.

(5) Spraying with insecticides to keep scale insects from attacking fruit.

(See Bul. 107; Fla. Agr. Exp. Sta., 1911.)

Diplodia Rot (Diplodia natalensis)

In the early stage this rot shows as a patch about the stem end similar to stem-end rot. The discoloration becomes darker as the decay proceeds, and appears as dark wide bands corresponding to the divisions between the segments. The fruit becomes black as the decay advances and very light in weight. The rot often advances quickly through to the "blossom" end, and a patch of discoloration shows there before all the peel is involved. The Diplodia rot often starts also in thorn punctures or similar injuries It is usually accompanied by the exudation of a small amount of thin gum, or a considerable . . .

[fol. 325] PLAINTIFFS' EXHIBIT No. 20

Proceedings of the Twenty-fifth Annual Meeting of the Florida State Horticultural Society, Held at Miami May 14, 15, and 16, 1912

Compiled by the Secretary, Published by the Society

The Relation of Handling to Decay of Florida Oranges in Transit and on the Market

H. J. Ramsey, Dept. of Agriculture

Mr. Ramsey: Ladies and gentlemen, members of the Florida Horticultural Society, this is the first time that I have had the pleasure of attending a meeting of this Society, or of giving an address before it. I hope that you will find some things of interest in the discussion this afternoon, and I shall briefly try to outline some of the work the Department of Agriculture has been doing in the state for the last six years. This season will probably be the last season the Agricultural Department will carry on its work to prove the causes and remedies of decay in transit in Florida.

MR. PRESIDENT, LADIES AND GENTLEMEN: The U. S. Department of Agriculture commenced the orange handling investigations in Florida some six years ago and have been carrying them on continuously since then up to and including the present season. At the time the work was started similar investigations were in progress in California. The results of the California work were conclusive and con-
[fol. 326] sistent and proved to the California citrus industry that handling was the big factor influencing keeping quality, and allow for decay on arrival and while being held for sale and distribution. Some growers thought much of the decay and the ill deserved reputation of the Florida orange was due in some measure to handling, and requested the Department of Agriculture to make an investigation of handling methods.

During the first two or three seasons the work was largely of a research nature and confined to but few localities. It was soon found that the same principles held true

with the Florida orange relative to handling as with the California fruit. The work was increased greatly in scope the last two or three years from both an experimental and demonstrational standpoint, and efforts were made to cover the entire citrus district and to do as much demonstrational and missionary work as possible.

Investigations extending over six seasons and covering practically the entire citrus district have conclusively proven that almost without exception the decay occurring in transit and while holding on the market is due to rough and more or less careless handling at the time of picking and packing. This has not only been proven by our experimental, carefully handled shipments, but also by the uniform, sound arrival of fruit from packing houses doing good, careful work. It has been fully demonstrated that fruit can be carefully picked and packed in a commercial way so that it will carry to the market in sound condition and hold up for a sufficiently long period to allow of its distribution and consumption.

These investigations were made possible only through the full and hearty co-operation of the citrus industry and the results were made of value by their commercial application to the handling of citrus fruits. In California the Department work had a marked and beneficial effect on the industry as the results were quickly and effectively applied to the commercial handling of all citrus fruits. The Cali- [fol. 327] fornia Fruit Growers' Exchange and other co-operative agencies made it possible to reach the growers and the industry in general more quickly and effectively. These organizations and the independent shippers applied the results to their business and constantly kept before the growers the importance of careful handling.

When the work was started in Florida there were but few if any purely co-operative associations and no large co-operative organizations, and the work was carried on largely with individuals in but few localities.

Three years ago there was formed the Florida Citrus Exchange, and through its support and co-operation we were enabled to get in closer touch with the whole industry. The Exchange as well as most independents appreciated the fact that soundness is one of the most valuable assets in marketing fruit. By working with such a large co-operative or-

ganization so closely in touch with the growers all over the state, we were enabled to disseminate the results of the work more widely. This is not discounting either, in the least, the splendid support and co-operation given the Department work by nearly all independent shippers, for as you all know, the work was carried on successfully in co-operation with both the Exchange and independent shippers.

The independents and buyers, knowing full well the desirability of putting the fruit on the market in sound condition, applied the results to their business and quite generally insisted on the most careful handling. This served to bring home that by more care in handling, the fruit could be put onto the Eastern market in good sound condition.

The same type of work was started in Florida during the session of 1906-'07 at the urgent request of the Florida citrus industry. Large percentages of decay were showing up in nearly all shipments and the Florida orange was saddled with a reputation for poor keeping quality. By years of experience the dealers had come to the conclusion [fol. 328] that Florida oranges were poor keepers and therefore either refused to handle them or else bought them at a considerable discount to the growers the necessity of careful handling and helped make the work effective.

I do not think that careless handling was practiced by the great majority of growers in the belief that handling did not influence the keeping quality, or that keeping quality did not determine to a great extent the market prices. On the other hand, rough handling was due more to the fact that growers and packers had no conception of what careful handling meant. Poor work by pickers and packers even at the present day is not due entirely to a lack of appreciation of what it means as regards keeping quality and reputation, but largely to ignorance of what constitutes careful handling.

Great care, much time and money is expended in bringing an orchard into bearing and in the production of large quantities of fine fruit. It does not seem to be a good business policy to nullify the results, of all the time and money spent in growing the fruit, by careless handling in harvesting the crop. A little extra care and money put into the handling of the fruit in its preparation for the market means sound arrival and increased returns. Very often this extra care in handling and packing will bring sufficiently

large returns to yield the grower a handsome profit, where otherwise his year's business would have shown a loss.

No one would have dreamed that such a great improvement, as has been made in handling, would have been possible in such a short time. Three or four years ago there was not a grading belt in the state, large hoppers holding several wagon loads of fruit were found in nearly every packing house, and in but few cases was the fruit accurately sized and graded and little care was exercised in picking, washing or packing. To-day nearly every packing house in the state handling any considerable quantity of fruit is equipped with modern machinery, grading belts, etc., and the large hopper is decidedly out of fashion. Quite a num- [fol. 329] ber of packing houses are now equipped with every modern convenience and device for carefully and economically handling the fruit. The fact that Florida is now almost on a par with California, makes the improvement which has been made seem even greater than that made in California, as the Florida industry had a much longer road to travel, and the change had to be more radical. Florida to-day has many packing houses on a par with any in California, and in many cases it is abreast with it in methods of picking and packing.

The people of Florida have reason to be proud of the great changes which have been wrought and the wonderful improvement made. There is, however, much to be done in order that Florida may maintain the reputation which it has built up for itself. More improvements must be made, there can be no let down in the standard of work and the necessity for careful handling must all the time be kept before the growers in order that the weaker links may be strengthened, and that Florida may continue to maintain a reputation for sound fruit.

The results of the six seasons' work have been consistent and striking throughout. During the last three seasons the work has been extended to nearly every shipping point in the state, and no effort has been spared to acquaint each and every grower with the results of this work, and the necessity of care in handling both in the field and packing houses.

We feel that it is now up to the industry to put into effect the results of the work as the cause of decay is generally known and the methods of handling to avoid losses

from decay has been most fully demonstrated. This has been done through actual work at a great number of packing houses, and by a series of meetings at various points where meetings were requested or sufficient interest was shown to warrant holding them. This season therefore will probably be the last that the Department of Agriculture will carry on the citrus handling investigations in Florida.

In connection with the work which has been done, it may be well to mention that we have in no way tried to do [fol. 330] police duty nor have we gone into groves or packing houses with any intention of criticizing the work there done, nor to check up foremen or managers. Our only excuse for doing the work was the good that might be accomplished, and we have been actuated by no other motive. Picking foremen and packing house managers have sometimes felt that we were there to check them up and to find fault. We wish to make it clear that we were there for no such purpose, but simply to bring home to the greatest possible number the results to be gained by more care in handling. In the majority of cases foremen and packing house managers have been able to strengthen themselves with their associations, to improve greatly the quality of work, and bring greater results to their associations by taking advantage of the results of our inspections and experiments.

The cause of decay in transit is an old story with most of you, but in order to more clearly bring out the results of our experiments, it may be well to refer to it briefly. The decay of citrus fruit which occurs in transit and on the market is in most cases due to the blue mold fungus. This fungus is a plant of a low order, and requires certain moisture and temperature conditions for its development and growth. Laboratory and field experiments have shown conclusively that the blue mold fungus has not the power to penetrate the sound, unbroken skin of the orange. Blue mold, therefore, can cause decay only after the orange has been injured in some way. These injuries are made in picking by thorn or nail punctures, stem punctures, clipper cuts, by dropping, or by rough handling in picking, hauling and packing. It is most fortunate, therefore, that this decay is dependent upon injuries as it can be cut down to almost nothing by reasonable care in handling.

Weather conditions influence decay to a greater or less extent. During the very dry weather a clipper cut or other

injury may dry up or heal over so quickly that the blue mold spores do not germinate, and during such times such injuries are apparently not so serious. However, after the [fol. 331] fruit has been packed tightly into a box, there is more or less condensation of moisture on the surface of the fruit and the spores may then germinate and start decay that will show up after its arrival on the market.

During times when the humidity is high and rainy weather makes thorough drying difficult, every injury offers a chance for the germination of the blue mold spores and the development of decay. The greatest care in handling is necessary during such periods in order that the fruit may be put on the markets in sound condition.

Low temperatures at time of packing and while shipments are in transit will often delay the development of decay only to have it occur as soon as the fruit is placed under warmer conditions. Many of our shipments this past season showed no decay on arrival but developed very high percentages of decay during the market holding period. Very low temperatures prevailed for a long time during the past shipping season and they were too low for rapid growth and development of the fungus during transit, but under warmer market holding conditions, the decay developed rapidly in all injured fruit.

Some decay occurs in the Northern markets which cannot be entirely eliminated by careful handling as it is caused by the stem-end-rot fungus. The original infection occurs in the groves and it is impossible to grade out the infected fruit at the time of packing. Very little of this decay shows up on arrival, but if the fruit is held at market under warm conditions, much stem-end-rot may develop during a two or three weeks holding period. In the season of 1910-'11 considerable stem-end decay developed on the market in shipments from nearly every section of the state. There was little or no difference found between carefully or commercially handled lots. During the season of 1911-'12 there was hardly any stem end rot from any section of the state and what did occur was found mostly in the fruit commercially handled. In but few cases was there enough of this decay to attract any attention at the market end or to de- [fol. 332] tract from the value of the fruit. Experimental shipments from groves showing high percentages of stem-

end decay during the season of 1910-'11 showed little or no decay from this cause during the past season.

The data relating to the occurrence of decay in transit and on the market given in the discussions to follow have reference only to blue mold decay.

The investigations during the last two seasons have been carried on mainly along three lines, as follows:

1. Picking and Field Handling: The work under this head included inspections of the picking and field work with a view of determining the actual amount of injury made in the field throughout the state. Along with this there was carried on more or less missionary work with pickers and foremen in order to make clear to them what careful work meant and the relation of injuries to decay.

2. Washing Experiments: A series of holding tests of washed and unwashed fruit were put up in various packing houses to determine the relation of washing to the keeping quality of oranges.

3. Shipping Experiments: These experiments consisted of a series of shippings and market holding tests to determine the relation of handling to the occurrence of decay in transit and on the market. These experiments were made not only to get data as to the relation of different methods of handling to the occurrence of delay, but also to demonstrate to growers and packers what could actually be accomplished by more care in handling.

Picking

During the season of 1910 and 11 and 1911-12, inspections were made of a great number of picking crews to ascertain the actual amount of injury being done in picking. The tables show only clipper cuts, long stems, and to some extent other visible abrasions or bruises, as there is no way of actually tabulating the amount of injury caused by dropping and other rough handling. The kind of work shown by [fol. 333] the tabulation of clipper cuts, long stems, etc., gives a fair indication of the character of the handling throughout.

A picker who is careless enough in his work to leave a large number of long stems, or to make a high percentage of clipper cuts usually is equally careless in other respects.

If a picker does good work in avoiding clipper cuts and long stems, he can in most cases be depended upon to be careful in putting the fruit into the picking sack or basket and in placing it into the field box.

These inspections and the filed work in connection with the shipping experiments conclusively showed that injury was not caused alone by clipper cuts or by leaving long stems; but in unmerous other ways, and that it is necessary to exercise the utmost care throughout the whole process of handling from the tree to the car. Injury may be done by placing the ladder carelessly against the tree so as to cause bruising of the fruit against limbs or cause it to be scratched by thorns. The picker may again puncture or scratch the skin of the orange by bringing it in contact with thorns or cut it with his fingernails. The fruit may be cut by the clippers as the picker is bringing the clipper in position to sever the fruit from the tree, or it may be done at the time when the stem is cut. Again, the stem may be cut long or jagged and sharp so that other fruits are injured by it. A long stem is worse than a clipper cut because during the journey of the fruit fom the tree to the packing box there are numerous chances for a long-stem orange to injure other fruit. This fault in picking is by far the most common and at the same time the most serious.

A good deal of injury is caused where large sacks are used for picking, in bruising of the fruit in the sack between the ladder and the picker's body. Where open-mouthed baskets are used, fruit is often bruised by dropping from a considerable height, into the basket and again in pouring it into the field boxes. Some pickers are expert in picking the fruit with one hand and with a dexterous twist have the fruit fall into a basket several feet below. Mr. Tenny's ex- [fol. 334] periments showed that oftentimes as high as 80 per cent decay resulted from dropping sound fruit 18 inches on to a hard surface, while 20 per cent decay was about the average. This shows the great importance of placing the fruit carefully into the picking sacks or baskets and into the field boxes.

Considerable injury is caused by putting fruit into boxes containing twigs and gravel or into boxes badly splintered and having nails projecting on the inside, by rough loading, by putting too much fruit into the boxes so that the boxes placed on top of them will rest on the fruit and not the

boxes below, by hauling the fruit in on springless wagons and by having the driver sit on the fruit instead of on a specially provided seat.

In all of our picking, we nearly always practiced the double cut, that is, we cut the stem long the first time, and as we brought the orange toward us, we made the second and last cut, where we could see just what we were doing. If this method is followed there is absolutely no excuse for making clipper cuts or leaving long stems. Besides, the orange is then in a position where it can be quickly and carefully placed in the picking sack. This method takes a little longer at first and more concentration on one's work, but a picker can soon get so that he can pick nearly as much this way as in the old way.

We prefer to use a canvas bag, holding approximately half a field box of fruit. This bag is open at both ends and is folded over and up from the bottom and attached by straps and snaps to rings on some portion of the bag above. The top of the bag is more or less closed so as to make it impossible to drop the fruit into the bag. When the sack is full the whole can be placed into the picking box, the snaps unfastened from the rings, and by catching hold of the top, the fruit can be left in the box by slowly pulling away the canvas. Good work can be done with open-mouthed baskets, but there is much temptation to let the fruit drop into them and to pour the fruit carelessly into the boxes. We also use gloves, usually canvas, so as to avoid cutting the fruit with fingernails.

[fol. 335] Table I.—Three Inspections of One Picking Crew, Showing Great Improvement

Picker No.	Jan. 14		Jan. 20		Mar. 4	
	Clipper Cuts Per cent	Long Stems Per cent	Clipper Cuts Per cent	Long Stems Per cent	Clipper Cuts Per cent	Long Stems Per cent
1	5.2	3.6	0.0	5.4	1.1	0.5
2	1.1	6.1	0.0	3.6	0.5	0.5
3	9.5	4.1	1.0	9.2	0.5	2.0
4	1.1	15.4	4.8	4.8	6.4	2.8
5	..	..	1.0	4.5	0.6	0.6
6	..	..	0.6	3.5	1.2	1.8
7	..	..	0.6	3.4	0.5	0.5
Crew Average	5.4	9.9	0.9	5.1	1.0	0.6

Fifty-seven inspections of the work of 46 picking crews during the season of 1910-11 showed an average of 4.2%

clipper cuts and 13.0 long stems. This is a fair indication of the average character of work which was being done in the state. The crews working by the box had 4.3% clipper cuts and 14% long stems. The crew working by the day had 3.7% clipper cuts and 9.6% long stems. The day paid crews were, as you would expect, doing the best work, but the difference is hardly as great as it should be. There was a great variation in the character of work being done by the different crews. The best crew had but 1% clipper cuts and .6% long stems, while one of the worst had 11.2% clipper cuts and 23.0% long stems. One crew was improperly picking but 1.6% of the fruit it picked, while the other was improperly picking 34.3%.

This illustrates one point we want to bring out and that is this: It does not depend so much on whether the crew is working by the day or box, as it does upon the foreman. The kind of work you get depends upon the foreman, or in other words, "the man behind the gun." If he insists on getting the proper kind of work, he is likely to get it, and on the other hand, if he is disinterested and exercises little or no supervision, his crew will do at best only indifferent work:

That improvement can be made, if the foreman insists on it, and knows something about handling men, is shown [fol. 336] in table No. 1. The first inspection, January 14, showed 5.4% clipper cuts and 9.9% long stems. The second, January 20, 0.9% clipper cuts and 5.1% long stems. The third, March 4, 1.0% clipper cuts and 0.6% long stems. It is interesting to note that this is a box paid crew and that this great improvement was brought about in spite of this handicap.

During the season of 1911-12 an average of the day picking showed 1.5% clipper cuts and 15.7% long stems, while the box picking showed 4.0% clipper cuts and 18.1% long stems. The colored crews did on the whole a little poorer work than the white crews. Crews where the foreman was picking, were picking about 28% improperly as against 15% for the crews where the foreman was not picking. The comparison of crews, with foreman picking and not picking is very striking and suggestive. A foreman should do no picking as he has his hands full looking after his crew. It should be his duty to see that the clippers are in good order, to see that field boxes are fit to put fruit into, and to exer-

cise supervision over the crew, putting a premium on quality rather than quantity. He could easily go over one or two boxes of each man's fruit once or twice a day to ascertain what kind of picking each man is doing. If a picker's work is faulty, he should call his attention to it and work with him to bring about improvement. Where a foreman does picking he can not exercise the proper supervision over the work of his men.

During the past season, an average of all inspections showed 3.4% clipper cuts and 17% long stems—a reduction in clipper cuts but an increase in long stems. The five best crews had 0.5% clipper cuts and had but 6.5% long stems, while the worst five had 8.3% clipper cuts and 31% long stems. While there has been a great improvement in the equipping of packing houses during the last year, there has not been a corresponding improvement in field handling. Much stress has been laid on picking and field handling, as good field handling is the very foundation of good keeping quality. It is the injury done in picking that is responsible. [fol. 337] to a great extent for decay in transit and on the market, and this injury cannot be eliminated and its ill effects counteracted by good packing house equipment. Field handling must be much improved before we can hope for a material reduction of decay in the average commercial pack going out of Florida. Co-operative associations find it to their advantage to have the picking done by an association crew. This gives uniformity at least as regards the quality of the work and the manager can be held responsible for the handling throughout. Where each grower picks his own fruit there is bound to be a great difference in the kind of picking done by the various growers and the ones doing good work suffer because of the poor work of their neighbors. Where the picking is done by an association crew, all growers' fruit is on the same footing as regards handling and if the manager is the right kind of man, he will see that he gets good picking. He must have good field handling to enable him to put the association fruit on the market in sound condition throughout the season. The necessity for careful picking and field handling is quite generally recognized, but the difficulty comes in getting the right kind of foreman. A foreman must know not only what good work is, but what it means to his employer. If he takes pride in his work and has the interest of his employer at

heart, he has qualifications which recommend him for such a position of trust, and it is a position of trust and responsibility, as a picking foreman can either make or lose money for the growers by the character of work performed.

In the past, premium has been put on quantity and not quality, and a man who has been picking oranges for thirty years is often the poorest picker and the hardest one to convert; in fact it is sometimes impossible to convert him. Nearly all picking up to recently has been done by the box and every inducement offered for careless work. If the pickers find that no premium will be put on quantity without quality, and that quality stands first, it may be that it will be easier to get good picking. If the industry, as a [fol. 338] whole, will insist on getting good work, without doubt the picking and field handling will be greatly improved.

Washing Experiments and Packing-House Equipment

A series of washing experiments were made during the season 1910-'11 to get at the effect of washing on the keeping quality of oranges. Each experiment usually consisted of eight boxes of fruit, four of which were picked and carefully handled by ourselves, while four were of a commercial pick of the same day and from the same grove. Two boxes each of the carefully and commercially handled lots were put up without washing and the two remaining in each lot were run through whatever machine was being used in the packing house. These different lots were packed up and held in the packing house for two weeks, after which they were opened and the percentage of decay determined by examination of every orange in each box.

Table No. 2

Orange Washing Experiment Season 1910-1911

Carefully picked and packed, not washed	1.0%
Carefully picked and packed, washed	4.1%
Commercial pick and pack, not washed	3.6%
Commercial pick and pack, washed	10.2%

There were in all 37 experiments in 32 different packing houses and 13 types of washers used. In the carefully

handled lots, the fruit not washed showed 1% decay as against 4.1% for the same fruit washed. In the commercially handled lots the fruit not washed had 3.6% while the same fruit washed had 10.2%. In the carefully handled lots washing increased the decay 3.1%, and in commercially handled 6.6%.

These results unquestionably show that washing as usually practiced very materially increases the decay. We do not advocate the doing away with the practice of washing entirely as there is much fruit in the state requiring washing in order that it may be put on the market in an at- [fol. 339] tractive and salable condition. Where fruit is free from sooty mold and reasonably clean, it would be advisable not to wash it and to only wash fruit, covered with fungus following the whitefly, or so dirty as to require cleaning. Wherever fruit is clean there is nothing to be gained in washing it.

It was found that much of the decay caused by washing resulted from the use of poor types of washers, or by allowing washers to get out of repair, or twigs and gravel to accumulate in them, and by lack of care in running them. Considerable decay follows the use of dirty water in the soaking tank and failure to properly dry the fruit or poor drying after the fruit is washed.

There was sometimes as much difference between the way two washers of the same types were operated as there was between different types of washers. The kind of cleaning which one gets and the amount of injury done in washing depends to a great extent upon the man who is running the washing machine. We cannot very well recommend any particular make of washer, but in a general way, we can indicate some of the points to be kept in mind regarding washers. From the stand-point of careful handling, a washer is preferable where the fruit is in sight all the time and where there is no pressure to bear down on top of the fruit. In the enclosed types one loses sight of the fruit while it is going through the washers and anything that gets out of order in them may do an immense amount of injury before it is discovered. Twigs, gravel, etc., may collect at certain points in them and injure a great amount of the fruit going through the washers. The first requisite to careful washing is to bring the fruit into the packing house and to the washer in sound, uninjured condition. The

more injury there has been done in the field, the more will be the decay resulting from the washing operations. The water in the soaking tank should be kept clean and changed at least once or twice a day. The question is often asked whether any chemical can be put into the wash-water to kill the blue mold spores in it or on the fruit. Considerable [fol. 340] work has been done along this line and nothing has been found that can be put into the water which will kill the blue mold spores and not injure the fruit. The only thing to do is to keep the fruit free from injuries.

Table No. 3.—Orange Washing Experiment—Comparison of Houses in Same Locality

	House No. 1, Per cent.	House No. 2, Per cent.
Carefully Handled		
Not Washed	1.1	0.2
Washed	14.1	0.2
Commercially Handled		
Not Washed	4.7	1.2
Washed	39.5	1.3

Table No. 3 gives a comparison of two experiments in two houses in the same locality and shows that washing can be done with little or no injury to the fruit. House No. 2 was doing exceptionally good work both in the field and packing house and there was practically no difference between the carefully and commercially handled lots nor between the washed and not washed. House No. 1 was doing very poor work both in the field and packing house. The decay in the carefully handled not washed lots in each house indicate that the fruit was essentially of the same character. The great increase in decay in the washed lots in house No. 1 was due to the fact that the fruit was carelessly run through an antique type of washer and little effort was made to dry the fruit; as for the most part, it was stacked up in the packing house in field boxes after running over a small indoor rack. At the time when the experiments were made in this house, much decay was showing up on the market in the fruit which was being shipped from it, and in some cases, the growers had to pay the freight on the shipments. House No. 2 had modern equipment throughout and was doing thorough drying. The comparison of the results

in these two houses is very striking and significant. In one case the growers were actually losing money on their citrus business, while in the other the growers were making a good [fol. 341] profit on their investment. This difference was not due to any great difference in the quality of the fruit or to methods of growing, but was due entirely to the type of handling being given the fruit in the two places.

Thorough drying is essential to good keeping quality and under average weather conditions, the artificial driers now in use are doing very good work. None of them, however, do perfect work during periods of rainy weather and high humidity, but on the whole are much preferable to out-door drying racks as they do away with the necessity of so much elevation and dropping.

A packing house should be arranged and so equipped as to carry the fruit on a level from the washer to the sizer. The aim should not be to get in a great amount of machinery, but to do away with every possible angle, elevation and drop, and to eliminate every source of injury.

Decayed fruit should not be left around in boxes or allowed to accumulate on the floor and under the packing bins. Where rotted fruit is allowed to remain in the house, any little breeze or disturbance will scatter great quantities of the spores of the blue mold fungus over all of the fruit in house. A clean, well-lighted packing house is not only an incentive for better work, but makes the fruit less liable to decay by lessening the chances for infection. A clean packing house is a good indication that genuine efforts are being made to do good work all along the line, as cleanliness or filthiness of a packing house is a good criterion of the kind of handling an association is doing.

Shipping Experiments

A series of experimental shipments were made to determine the relation of field and packing house handling to decay in transit and on the market. Each shipment consisted of six boxes, two very carefully picked and packed by the Department men, two commercially picked but carefully packed, and two handled in the ordinary commercial [fol. 342] manner. The fruit in each experiment came from the same grove, was picked and packed at the same time and shipped out in the same car. These lots were then ex-

pressed from whatever city in the north where the car was sold, to Washington, D. C. The fruit was then carefully examined, orange by orange, on its arrival at Washington and at intervals of one, two and three weeks after arrival. We tried to secure comparable conditions for all lots in each experiment in everything but the type of handling.

At the time this fruit was picked and packed, an equal amount of fruit of the same pick in each lot was set aside in the packing house, loose in field boxes, and was then packed up three or four days later and sent out as a delayed shipment. This was done in order to clear up the much discussed question of delaying or curing the fruit in the packing house before shipment.

During the season of 1910-'11 there were sent out 79 shipments from more than 40 packing houses, covering the entire shipping season. The results were most striking and consistent and proved conclusively that handling is the one big factor in determining the keeping quality. An average of the 79 shipments shows 7% decay on arrival in the commercially handled fruit as against only .6% in the same fruit carefully handled. At the end of a three weeks' holding period on the market, the commercially handled fruit showed 14.2% and the carefully handled but 1.9%.

Table No. 4—Florida Orange Shipping Experiments, Season of 1910-11—Average of 79 Shipments—Per Cent of Blue Mold Decay.

	On Arrival. Per cent	1 week Later, Per cent	2 weeks Later, Per cent	3 weeks Later, Per cent
Careful Pick and Pack	0.6	1.1	1.6	1.9
Commercial Pick and Pack	7.0	10.8	13.2	14.2

[fol. 343] Table No. 5.—Florida Orange Shipping Experiments, Season 1911-12—65 Shipments from 37 Houses—per Cent Blue-mold Decay

	On Arrival. Per cent	1 week Later, Per cent	2 weeks Later, Per cent	3 weeks Later, Per cent
Careful Pick and Pack	0.6	0.9	1.4	2.2
Commercial Pick and Pack	4.0	6.8	10.4	14.2

During the season of 1911-'12, 65 shipments were made from 37 houses and corroborated fully the results of the previous season's work. The commercially handled fruit had 4% decay on arrival and 14.2% at the end of three

weeks. The carefully handled had .6% on arrival, the same as the season before, and only 2.2% at the end of three weeks. There was a decrease of 3% in decay on arrival in the commercial handling for the season of 1911-12, while the carefully handled fruit showed the same decay as during 1910-11. The decay in the commercially handled fruit went up 14.2% during the holding period and equalled that of the previous season.

Referring back to the table No. 4: We find that there is a difference of over 6% in decay between the commercially and carefully handled fruit on arrival. 6% of 4,000,000 boxes is 240,000 boxes of fruit rotted and decayed before it even reached the market and which could have been saved by more care in handling. The grower paid freight, packing and selling charges on all of this decayed fruit, but realized nothing from growing it or to pay interest on his orchard investment. The actual money loss on this amount of decayed fruit would easily reach $500,000.00, to say nothing about the ill effect on the reputation of Florida fruit and the depreciation in value of the fruit actually arriving in sound condition. The loss in actual decay can be figured in dollars and cents, but there is no way to capitalize reputation.

As you all know, it is not only important and sufficient that the fruit arrive in sound condition, but also that it hold up for a period of two or more weeks to allow for its [fol. 344] distribution and consumption. The consumer prefers to buy fruit that will hold in reasonably sound condition for some time, and the dealer naturally wants to supply his customers with what they want and is willing to pay high premiums for fruit on which he can depend to arrive and hold in sound condition. This illustrates to some extent the importance of building up and sustaining a reputation for good, sound, fruit, honestly and attractively put up.

Our experiments show conclusively that it is possible to so handle Florida citrus fruits that they can be put on the market in practically sound condition and can be held two or three weeks after arrival without any material increase in decay. This is illustrated by reference to the tables showing the decay in shipments during the past two seasons. At the end of three week's holding period in 1910-11 the decay

had increased from 7% to 14.2% in the commercially handled lots, while in the carefully handled, the decayed from .6% to only 1.9%. The 1911-12 results showed 14.2% for the commercially handled and only 2.2% for the carefully handled at the end of the market holding period. If further proof is necessary to demonstrate that fruit can be put on the market in sound condition, one has only to observe the results being obtained commercially by packing houses doing good work. A table is here shown giving comparisons of commercial shipments from packing houses doing good and poor work, and the results of such comparisons are striking enough, it would appear, to convince the most skeptical.

Table No. 6.—Comparison Commercial Shipments 1910-11 from Five Packing-houses Doing Careful Work and Five Packing-houses Doing Careless Work—per Cent Blue-mold Decay

	On Arrival, Per cent	1 week Later, Per cent	2 weeks Later, Per cent	3 weeks Later, Per cent
5 Careful	1.4	3.1	4.1	4.5
5 Careless	17.6	27.9	34.0	37.1

Many growers and packers advocate the holding and curing of oranges in field boxes in the packing house for three [fol. 345] or more days to allow the fruit to wilt. The claim is made that fruit will pack more easily, that a greater number of culls can be thrown out, and that considerable decay can be eliminated before packing.

Table No. 7.—Immediate vs. Delayed Shipments, Average 56 Shipments from 28 Houses—Season 1911-12—per Cent Blue-mold Decay

	On Arrival, Per cent	1 week Later, Per cent	2 weeks Later, Per cent	3 weeks Later, Per cent
Commercial handling delayed	5.8	8.7	11.7	15.1
Commercial handling immediate	2.9	5.7	9.7	13.5
Careful handling delayed	0.7	7.0	1.5	2.0
Careful handling immediate	0.5	0.9	1.4	2.3

A comparison of 56 shipments from 28 packing houses this past season, shows that delaying fruit in the packing house for three or four days before packing greatly increases the decay shown in the commercial shipments.

The more injury there has been made in handling, the more serious and disastrous is the practice of so-called curing. When fruit is carefully handled and uninjured, a delay of two or three days does not seem to make any material difference as to decay. Under ordinary commercial conditions, it is decidedly unwise to hold fruit in the packing house for any length of time. The fruit is just that much older and that much nearer its life limit when it reaches the consumer. In our investigations we have found nothing to justify the practice of delaying or curing, and the best results are obtained where fruit is packed and shipped out as soon as possible after picking.

Enough experimental work has been done to make the results conclusive. No effort has been spared to make the results available to the industry, by demonstrations and meetings, and we feel that the Department has done everything that can be reasonably expected of it. A bulletin will soon be issued covering fully all the phases of the handling [fol. 346] work during the past six years and we hope to have this ready for distribution by the beginning of the next citrus shipping season.

The principles and necessity of careful handling are pretty generally known and recognized, and what is now needed are the right kind of men, for foremen and managers, men who appreciate what careful handling is and means, and who will not tolerate careless, slovenly work.

Results and reports of the Department's earlier work along this line in Florida is to be found in the annual reports of this Society for the years 1907 to 1910 inclusive. The results of the field work during the season of 1910-'11 and 1911-'12, have been given to some extent in this paper.

This work forms a part of the activities of the Office of Field Investigations in Pomology, under the direction of A. V. Stubenrauch, expert in charge. The following members of the staff were associated in field work in Florida during the seasons of 1910-'11 and 1911-'12: H. J. Ramsey, A. W. McKay, B. B. Pratt, C. S. Pomeroy, K. B. Lewis, G. M. Darrow and J. F. Fernald.

Mr Burton: I would like to ask Mr. Ramsey if it is the purpose of the department to have this service continued next winter in this state.

Mr. Ramsey: No, we do not expect to do any work in the state next winter; at least, that has been the decree by the ones who have it in hand.

Mr. Burton: I think that the growers of Florida ought to adopt the suggestions of Mr. Ramsey. I do not know of any work that has been done in this state that has contributed so largely to the citrus industry as the work the department has done. I believe that this Society ought to pass a resolution expressing their thanks, and that they should put it up to the department at Washington and urge that this work be continued, because it has hardly begun. There are a few [fol. 347] packing houses that are equipped for handling the fruit properly. The growers themselves have to be shown how to equip their houses right; they have to be shown how to operate them. There is not a grower here who is not in position to appreciate Mr. Ramsey's talk. I believe it would be nothing short of a calamity if we do not have these gentlemen in this state, not only next winter, but for a series of years, as the work is just beginning to gain headway. We need these men and their ideas in every community in this state. Even in this community, I think they will tell you that Mr. Ramsey's suggestions have been worth thousands and thousands of dollars. I could name scores of communities where they feel just that way about it. Therefore, I move that a resolution of thanks be extended to Mr. Ramsey and his co-workers, and that the department be requested to allow their work to continue.

Mr. Hart: I take great pleasure in seconding Mr. Burton's motion.

(Motion carried.)

[fol. 348] PLAINTIFF'S EXHIBIT No. 21

The Handling and Precooling of Fruits for Transportation

by A. V. Stubenrauch, B. S., M. S. A., in Charge of Field Investigations in Pomology, Bureau of Plant Industry, U. S. Department of Agriculture, Formerly Assistant Professor of Horticulture, University of California

Written Specially for use in the Pacific Horticultural Correspondence School, Portland, Oregon

Contents

Side page

Introduction
Specialization in Fruit Production and Marketing
The Advantages of Sound Fruit
Handling Fruits for Transportation
Causes of Deterioration and Decay
Relation of Type of Handling to the Occurrence of Blue Mold 349
The Prevention of Decay is Largely a Business and Administrative Problem 351
Factors Governing Behavior While in Transit 352
Refrigeration of Fruit While in Transit
Influence of Temperature upon Carrying or Storing Qualities
Influence of Precooling Before Shipment
The Reasons for Precooling and Refrigeration
How Precooling is Accomplished
Systems of Precooling
The Warehouse Precooling Plant
The Car Precooling Plant
Warehouse vs. Car Precooling
Advantages and Limitations of Precooling

Suggestions for Study

Read carefully each chapter or paragraph to find points treated—then return and carefully study several times the important points to fix them in your memory, with the object of taking the examinations later.

[fol. 349] Marking passages of special interest to you will enable you to refer to them easily and helps to fix them in your memory.

The italics in this article are by the principal and are intended to call special attention to these passages, which should be carefully studied as an aid in examination and to fix these points in the memory.

Copyright, 1912, by Pacific Horticultural Correspondence School

All Rights Reserved

Relation of Type Handling to the Occurrence of Blue Mold

It follows from what has been said regarding the character of the decay fungus affecting fruits while in transit, storage or in the market, that the type of handling given the fruit in preparing it for marketing has a direct influence upon the occurrence of the decay. This general principle has been developed from the comprehensive investigation of the Bureau of Plant Industry. It has been shown that the problems of controlling most of the decay occurring in various fruits can be reduced to a minimum if the system of handling is such as to insure the packing, shipping and marketing of the product in a sound condition. Every effort then should be directed toward this end.

Mechanical injuries to fruits include various kinds of breaks in the skin produced by rough or careless handling. These injuries differ in different fruits. In citrus fruits the most common forms of injury are those made by the clippers in severing the fruits from the tree; punctures of various kinds produced either by long stems or through dropping against the sharp edges of the picking boxes; cuts or other punctures from loose or projecting nails in field or packing boxes, or rough splinters from broken boxes; small punctures and scratches made by gravel, dried twigs or sand in the picking boxes, finger nail scratches made by pickers or packers; bruises from dropping; abrasions, punctures, scratches or bruises of various kinds produced by imperfection in the machinery of packing houses.

[fol. 350] In apples and other deciduous fruits, the most common forms of injuries are due to rough handling and bruising in picking; breaking or pulling out stems; punctures from gravel, nails in boxes or dropping or rubbing

against sharp edges of boxes or packing tables; finger nail scratches and other abrasions made by rough handling in grading, wiping or packing. Deciduous fruits in general are more easily injured by bruising in dropping or squeezing than is the case with the citrus fruits, hence the importance of avoiding all extra handling and dropping is doubly urgent. In grapes, the most common form of injury occurs at the pedicel of the grape berry. In some varieties of grapes the slightest bending aside of the berry causes a small crack or break, frequently too small to be observed by the naked eye, nevertheless sufficient to allow the decay to gain entrance.

The relationship between the occurrence of decay and rough or careless handling having been established, its prevention ought to be a comparatively simple matter. Yet it is not very simple. Most handlers of fruits realize in a general way that care must be exercised in picking and packing fruits, but rarely is the extent or likelihood of injury in handling realized or appreciated until it is strikingly demonstrated. Few realize how much injury is being done in their handling operations until actual counts are made and the records exhibited. Records of injuries running from 10 to 50 per cent and in some cases as high as 80 per cent have been found in oranges hand-ed with what the grower thought was as great case as could possibly be given. From ten to fifteen per cent of apples have been found to be injured in various ways. Likewise in grapes, the injuries frequently reach large proportions—too large to be accurately counted.

In the preparation of fruit for market in the past, the greatest stress and emphasis have been placed on getting the work done as rapidly and as cheaply as possible. A premium is thereby placed on careless work. The workmen have not been in the habit of wilfully puncturing or bruising the skin of the fruit which they handle. Their [fol. 351] main efforts have been expended in getting the work done as expeditiously as possible; the injuries which they do are incidental and the whole blame lies on the system of carrying on the work.

The Prevention of Decay is Largely a Business and Administrative Problem

The prevention of decay thus becomes largely a business and an administrative problem. *The business of fruit handling must be organized to insure proper and careful handling methods.* This deals with the training, direction and supervision of the labor. The *quality* of the work performed instead of its *volume* of the fruit industries the piece work system has prevailed, the pickers, packers and handlers being paid by the box. It is only natural under this system to find that the workmen will endeavor to secure rapidity and volume usually at the expense of the quality of the work performed. The reorganization of the system of business methods from the piece work system to the day payment plan usually results in marked improvement. This, however, is not sufficient in itself. Merely changing the system of payment to the per diem plan will not accomplish the desired results. The workmen cannot be depended upon to correct their mistakes or carelessness without constant supervision and direction. We have seen as poor and as careless work done by day-paid labor as that of workmen paid by the box; in fact, in some instances better results have been obtained by properly supervised and directed gangs of workmen paid by the box than from day-paid gangs working without special supervision in the same district. The character of work done depends upon *the foreman* or manager whose sole business it should be to see that the workmen are performing careful and proper work. Upon the *efficiency of the foreman* and his ability to direct the workers under his supervision rests the practicability of handling fruit without injury in order to insure its delivery in distant markets in sound condition. This principle holds true through all stages of preparing [fol. 352] the fruit for market—in the picking, hauling, cleaning, grading, packing and loading operations.

Factors Governing Behavior While in Transit

After the grower, the picker, the teamster, the grader, the packer and the car loader have each done his share in properly preparing the fruits for transportation or storage, the conditions under which the fruit is held have an im-

portant influence upon its keeping qualities. As has already been pointed out, many of the regions of the country adapted to the production of high-class fruits are located at long distances from the centers of consumption, and a considerable period of time is required to transport the packed fruit to market. This period of time varies from a few days to as long as three weeks, during which a very considerable deterioration may occur unless special conditions are provided to prevent it. This time element is most important for the soft and quick-ripening fruits such as berries, cherries, peaches, plums, prunes and least important in the case of the harder and slow-ripening fruits such as apples, some varieties of pears and the citrous fruits—oranges, lemons and pomelos.

Next to the type of handling given the *the* fruits, the *most important factor* in their sound transportation to market and storage *is the temperature* at which they are held. This temperature factor is most important for the softer fruits and least important for citrous fruits, although it is very important for all fruits. It would be impossible to transport the soft fruits to market without some means of cooling them and holding them cool * * *.

[fol. 353] PLAINTIFFS' EXHIBIT No. 22

Better Fruit

Volume VII November, 1912. Number 5

Latest Census Report on the Fruit Industry of the United States

By the Census Bureau of the Department of Agriculture, Washington, D. C.

Better Fruit Publishing Company, Publishers, Hood River, Oregon

Fruit Handling and Pre-Cooling Investigations

A. V. Stubenrauch, United States Department of Agriculture, Before Washington State Horticultural Convention at Clarkston

The request of your secretary specified that a paper on the pre-cooling of fruit was desired for this meeting. It

is wholly impossible, however, to discuss the question of the pre-cooling of fruit without reference to the importance of the handling given the fruit in preparing it for shipment or storage, and it will be necessary to devote a large part of the discussion to handling problems. The term "pre-cooling" has been applied to the method of promptly and rapidly reducing the initial temperatures of produce intended for shipment. The work requires special equipment aside from that needed to maintain the low temperature after the initial heat has been removed. Pre-cooling, or chilling, has been used for a number of years in preparing meats for shipment or storage, but as far as is known the first application of this process to the handling and shipment of fruits was made in 1904 by Mr. G. Harold Powell, who was then in charge of the fruit transportation and storage investigations of the Bureau of Plant Industry. [fol. 354] The first work consisted of the pre-cooling of peaches intended for shipment from Georgia to Northern markets. The equipment used was necessarily rather crude, yet some very definite results were obtained. Later on the process was applied to oranges and deciduous fruit in California, and since Mr. Powell's early work special attention has been given by the office of field investigations in pomology to the investigation of the problems connected with the pre-cooling of different fruits. In addition to oranges and peaches, these investigations have been extended to table grapes in California, and last season work was begun on cherries and fresh prunes in Oregon and raspberries in Washington. Special equipment has been supplied in order to enable the work to be carried on at different points in the United States.

In an article on "The Pre-Cooling of Fruit" in the Year Book of the Department of Agriculture for 1910 a general discussion of the subject was presented, and the following paragraphs are quoted from that article: "The Reasons for Pre-Cooling.—During the maturing of a normal fruit on the tree certain chemical and physiological changes are constantly taking place within the fruit itself. These changes, which result in the acquirement of quality and flavor, constitute the ripening process. After a certain point is reached the fruit becomes over-ripe, quality and flavor are lost and deterioration progresses until eventually

the fruit is destroyed by fungous decay or fermentation, or through destructive physiological changes. A fruit may be considered as a living organism which has a definite span of existence, the length of this span depending upon the conditions surrounding the organism. The most important factor which modifies this span of life is temperature. When the fruit is removed from the parent plant the life processes constituting ripening are materially hastened, and the life span is greatly shortened if the fruit is allowed to remain warm for any length of time. Hence the importance of reducing the temperature as promptly and rapidly as possible after the fruit is picked. The length [fol. 355] of the life span differs with the character of the fruit. It is shortest in the soft fruits, such as berries, cherries, peaches, apricots, plums and most pears, the longest for the harder fruits, citrus fruit and apples. It varies with different varieties within the same group of fruits. Some varieties of apples, for example, keep longer than others; lemons keep longer than oranges. The importance of quick and prompt cooling (pre-cooling), then, is greatest in the case of the soft fruits and least for the harder fruits. Experience so far confirms this rule. Aside from the breaking down from over-ripeness fruits are subject to premature decay, due to the attacks of various fungi. The most common forms of these fungi, however, have not the power to penetrate the sound, unbroken skin of a healthy, normal fruit Most of the decay occurring in fruits in transit and storage starts at injuries and breaks in the skin, caused almost entirely by rough handling in preparing the fruit for market, either in picking, grading, hauling or packing. Wounds, bruises, scratches or abrasions of any kind allow the organisms of decay to gain entrance. Other fungi which are not dependent upon injuries to start attack fruits in transit and storage, but these forms of decay are much less prevalent. The germination of the decay spores, which are analogous to the seeds of higher plants, is dependent upon proper moisture and temperature conditions. Germation does not take place while the fruit is perfectly dry or when the temperature is low. After the spores have germinated, however, and the decay has started within the fruit, even as low a temperature as 32 degrees Fahrenheit will not wholly check it. Growth of

the mold is only retarded and the decay continues slowly to develop."

The prompt and rapid reduction of the temperature below the point where decay spores germinate prevents the development of the disease. Some fruits which have been rendered susceptible through mechanical injuries occurring in the handling may be transported with only slight loss from decay when promptly cooled. It is not safe, [fol. 356] however, to depend upon pre-cooling to prevent decay which follows the improper handling. Pre-cooling should never be expected to replace proper work. The fact that it does not always effectively replace careful handling is shown by the bureau investigations with table grapes. It has been the policy of the bureau to advise conservative caution in the application of pre-cooling on a commercial scale. It was realized that pre-cooling would not prove a penacea for all of the troubles which the different fruit industries were experiencing in transporting fruits to market. The importance of careful handling was consistently urged and all efforts were made to emphasize the necessity of handling the various fruits in a manner to insure their sound carrying qualities. The bureau work has shown that there is a consistent relation between the type of handling given fruits in preparing them for shipment and their behavior during transit and storage. There is practically no way to avoid responsibility for the occurrence of decay and deterioration due to careless handling on the part of the grower or shipper who prepares the fruit for market. To use pre-cooling as a means to overcome difficulties which ordinarily can be eliminated by packing the fruit in sound condition is not only poor policy but is dangerous to the reputation of the product. Pre-cooling does not absolutely prevent decay. The reduction of the temperature simply arrests the development of mold, and therefore the deterioration due to these agencies occurs after the fruit arrives in the market. Such fruit will soon gain a reputation of poor shipping qualities. The correctness of this early conclusion regarding the uses of pre-cooling have been emphasized by later work with table grapes. With this class of fruits the results of three consecutive seasons show that pre-cooling does not effectively replace careful meth-

ods of handling. There was in some instances a slight reduction in decay due to injuries or to other causes in cars which contained pre-cooled fruit, but the benefit from the [fol. 357] pre-cooling process without attention to careful handling were not sufficient to justify the extra trouble and expense.

In order to emphasize the results from the table grape handling and pre-cooling work the accompanying tables and charts, giving summaries of the three seasons' work on Tokay grapes from California, are presented. A glance at the figures (Table I) shows that by careful handling, aside from pre-cooling, the decay in the grapes shipped from California may be held at a minimum. The figures presented comprise the results obtained from the systematic handling, shipping and inspection of a large number of crates of grapes produced under a wide range of conditions. The figures also show the behavior of this fruit after arrival in market. Inspections were made on the day of arrival, after holding two days and after four days, the fruit being held under open market conditions and without refrigeration. The consistent effect of careful handling after the fruit arrives in market is strikingly shown. The importance of having such perishable fruit hold up after it arrives in market need hardly be emphasized. Grapes which arrive with as low a percentage of decay as is shown in the figures for the carefully handled lots, on arrival in New York, may be reshipped to neighboring cities with perfect safety, whereas the commercially handled lots deteriorate so rapidly after arrival that they must be immediately consumed, otherwise a large proportion of the fruit is wasted. The figures also show the percentages of decay obtained from grapes packed in ground cork and redwood sawdust. The use of a filling material in packing California table grapes reduces the decay percentage to a minmum. It has not been thought wise to advise the change from the old method of packing in crates to one using a filler because of the difficulty of introducing a new style of package under commercial conditions. From last season's experience, however, there is some indication that at least the best grades of grapes may be packed with this filler, and an attempt

will be made to introduce this new system of packing for ordinary commercial shipment next season.

[fol. 358] Table II shows the results from comparable shipments of pre-cooled and non-pre-cooled table grapes to New York during three consecutive seasons. No attempt was made to handle these grapes carefully; the ordinary commercial pack was used. The pre-cooling was accomplished by means of a cold-air blast circulated through the cars until the average temperature of the fruit was reduced to a point near 40 degrees. The figures show that decay was slightly less in the pre-cooled cars, but the differences are not sufficient to warrant any considerable extra expense. A greater reduction in decay was accomplished by careful handling without pre-cooling than by pre-cooling alone. This is a most important point and one which cannot be too strongly emphasized. The tendency to regard pre-cooling as a means to overcome all of the difficulties which are experienced in transporting fruits is widespread, and while we feel that this system of preparing fruits for shipment over long distances is a most important one and one which will have a great influence on the carrying qualities of fruit after the grower, the packer and the shipper have done their share to insure the preparation of the fruit for market in sound condition, pre-cooling must not be depended upon to replace all of these special efforts. The fruit handling investigations of the Bureau of Plant Industry have been in progress about ten years. During that time a very comprehensive study has been made of the relationship of handling various kinds of fruit to their behavior in transit, in storage and while on the market. This study has been extended to the California orange and lemon, the California table grape, the Georgia peach, the Florida orange and pomelo, and last season investigations were begun with red raspberries in Washington and cherries and fresh prunes in Oregon. The results of these studies, covering a wide range of fruits, are consistent throughout and show a very definite relation between the methods of handling the fruits and their behavior after packing. I will not attempt to give all of the data which have been accumulated along these various lines. It is [fol. 359] however, important to present some of the results in order to show how conclusive and how consistent the work has been.

In table III the results from the shipping experiments with Florida oranges during the season of 1910-11 are shown. The fruit used in these experiments was obtained from seventeen packing houses located in various parts of

Table I.—Shipments of Tokay Grapes from Lodi, California, to New York, Seasons of 1908, 1909, 1910—Average Percentages of Decay.

Season of 1908	On arrival	arrival 2 days after	arrival 4 days after
Packed in ground cork	1.6	4.2	6.6
Carefully handled in crates	4.2	7.8	16.2
Commercially handled in crates	9.6	14.7	33.9
Season of 1909			
Packed in redwood sawdust	0.2	0.6	0.7
Carefully handled in crates	0.9	2.6	5.1
Commercially handled in crates	4.4	7.4	15.8
Season of 1910			
Packed in redwood sawdust	2.2	3.6	4.2
Carefully handled in crates	4.0	5.8	9.3
Commercially handled in crates	6.5	9.6	15.8

Table II—Precooled and Non-precooled Commercial Shipments of Tokay Grapes from Lodi, California, to New York, Seasons of 1909, 1910 and 1911—average percentages of Decay

Season of 1909	On arrival	2 days after arrival	4 days after arrival
Precooled shipments	6.6	12.7	16.8
Non-precooled shipments	7.5	10.9	15.1
Season of 1910			
Precooled shipments	7.4	11.1	15.1
Non-precooled shipments	8.7	12.2	17.5
Season of 1911			
Precooled shipments	6.5	12.2	16.7
Non-precooled shipments	8.1	12.8	17.0

Table III.—Florida Oranges Shipping Experiments, Season of 1910-11—Average Percentage of Decay in Eighteen Experiments in Seventeen Packing Houses

	On arrival	At end of 1st week	At end of 2d week	At end of 3d week
Careful pick and pack	0.7	1.4	1.7	2.0
Commercial pick, careful pack	2.9	5.3	7.0	7.9
Commercial pick and pack	6.7	12.1	15.3	16.6

[fol. 360] Table IV:—Red Raspberry Handling Experiments, Puyallup, Washington—Season of 1911—Average Percentage of Decay

	4 days in refrigerator	6 days in refrigerator	8 days in refrigerator
Carefully handled:	car.	car	car
On withdrawal	0.2	0.3	1.7
One day after	0.6	3.5	7.8
Commercially handled:			
On withdrawal	1.4	7.2	22.2
One day after	12.2	27.6	44.3

Table V.—Red Raspberry Precooling Experiments, Puyallup, Washington—Season of 1911—Average Percentage of Decay

	4 days in refrigerator	6 days in refrigerator	8 days in refrigerator
Precooled, commercially handled:	car	car	car
On withdrawal	2.1	9.1	18.4
One day after	9.5	19.1	35.2
Non precooled, commercially handled:			
On withdrawal	5.9	15.4	27.4
One day after	16.5	28.8	45.8

Table VI.—Carefully Handled and Commercially Handled Cherries at Salem, Oregon, 1911—Average Percentages of Decay

	5 days in refrigerator	10 days in refrigerator	15 days in refrigerator
Carefully handled:	car	car	car
At withdrawal	0.5	1.5	4.3
Two days after	3.5	3.5	7.3
Commercially handled:			
At withdrawal	2.8	12.3	16.0
Two days after	10.8	21.4	26.1

Table VII—Carefully Handled and Commercially Handled Fresh Prunes, Salem, Oregon, 1911—Average Percentages of Decay

	10 days in refrigerator	15 days in refrigerator	20 days in refrigerator
Carefully handled:	car	car	car
On withdrawal	0.7	0.4	2.7
Two days after	1.2	1.4	3.8
Four days after	1.6	2.1	4.7
Six days after	2.1	3.7	6.9
Commercially handled:			
On withdrawal	3.5	7.1	6.8
Two days after	5.6	8.8	9.7
Four days after	9.3	11.5	19.3
Six days after	8.7	16.6	23.3

the Florida citrus districts. The fruit used, therefore, was produced under a wide range of conditions and the investi-

gation was continued throughout the entire shipping season. The data are, therefore, the result of a large number of [fol. 361] experiments consisting of a sufficient number of boxes of fruit to place the work on a commercial basis. A glance at the figures and the diagrams shows the consistency of the general principle expressed above. Of all the series of oranges picked, packed and shipped by the bureau workers, the percentage of decay was only .7 per cent on arrival at Washington, D. C. The fruit was held for three weeks, inspections being made at the end of the first, second and third weeks. At the end of the first week the carefully picked and packed fruit showed 1.4 per cent, while at the end of the second and third weeks, respectively, 1.7 and 2 per cent decay developed. Contrast these figures with the fruit picked and packed under ordinary commercial conditions. On arrival the commercially picked and packed fruit had 6.7 per cent decay, and after holding one week 12.1 per cent; after two weeks 15.3 per cent and after three weeks 16.6 per cent.

Red Raspberry Handling and Pre-Cooling Experiments. —This work was begun during the season of 1911, and records from only one season are available. (See tables IV and V). All pre-cooling was done after the fruit was loaded into the cars. The data obtained were clear cut and are consistent with the general principles developed with other fruits; they are presented as additional corroborative evidence. This work will be continued and extended until full and conclusive records shall have been completed. It was impracticable to obtain the inspection data after shipment to Eastern points. The raspberry crates were, therefore, held in an acide refrigerator car at Puyallup, Washington, and the lots of fruit were withdrawn after holding periods, which represents trips of four, six and eight days, respectively. The conditions for rapid cooling in the iced car at Puyallup were considerably more favorable than obtain during a transcontinental trip. The car was kept fully iced throughout the season and at no time was a full carload of fruit on hand. The fruit held without pre-cooling was, therefore, cooled much more rapidly than would have [fol. 362] been the case under actual shipping conditions. It is necessary to take these factors into consideration in making comparisons of pre-cooled and non-pre-cooled

crates. It is only fair to assume that under shipping conditions the decay in non-pre-cooled berries would be higher than shown by these experiments. The point to be drawn from these figures is the consistently clear-cut results from careful handling with this very perishable fruit. The two tables should be considered separately and are not comparable. Only the data obtained from actnal comparable series of experiments are included in the figures shown in each table, and the series for the handling and pre-cooling experiments are not the same. The figures for the percentages of decay in the pre-cooled lots do not tell the whole story. The pre-cooled berries presented a very much brighter and more favorable appearance than the non-pre-cooled, and the consensus of opinion of all who examined the fruit was that a material benefit resulted from the pre-cooling. This need not in any way detract from the importance of the results from the handling experiments.

Cherry and Fresh Prune Handling Experiments—This work was begun at Salem, Oregon, during the season of 1911. The results are given in order to further emphasize the consistency of the careful handling principle. (See table VI). As in the case of the raspberry experiments, it was impracticable to make inspections after actual shipment and the lots were held in an iced car for periods representing trips of ten, fifteen and twenty days, respectively. The conditions were only approximately those of a car in transit, as owing to the car being only partially filled the temperature conditions in the car were more favorable than during shipment with a full carload. The fruit was held after withdrawal from the car under open market conditions. Careful handling in the work with cherries and prunes consisted not only in using care in picking and packing but in grading or culling out all imperfect fruits. The season was very unfavorable, there having been consider- [fol. 363] able rain during the shipping season, and a large proportion of the fruit was cracked and otherwise damaged. These were carefully culled out as far as practicable in the carefully handled lots; in the commercial packs little attention was paid to culling out the imperfect fruits.

PLAINTIFFS' EXHIBIT No. 23

Proceedings of the Twenty-sixth Annual Meeting of the Florida State Horticultural Society Held at Deland April 29, 30, May 1 and 2, 1913

Compiled by the Secretary, Published by the Society

Citrus Fruit Handling and Storage

A. W. McKay, Assistant in Fruit Transportation and Storage Investigations, U. S. Department of Agriculture

The citrus fruit handling and transportation investigations of the Bureau of Plant Industry were begun in Florida in 1906 and continued until the season of 1911-1912. The results of this work have been presented to the members of this Society at various annual meetings by Messrs. Tenny, Stubenrauch and Ramsey, and the majority of you are doubtless familiar with what has been accomplished. At the end of last year it was felt that six consecutive seasons of experimental work had demonstrated thoroughly the causes of blue mold decay in Florida oranges, in transit and on the market, and the value of careful handling in preventing such decay. If any further demonstration was needed, or is needed, it is furnished on a commercial scale by an increasingly large number of growers and shippers [fol. 364] of citrus fruit who have adopted careful handling methods. There are now packing houses in the State whose records are conclusive evidence that it is not only possible but practicable, to handle oranges and grapefruit so that they will arrive on the market with little or no decay, even under the most unfavorable weather conditions.

The work of the office of Field Investigation in Pomelos in Florida, this season, has related more directly to another phase of the fruit handling problem. Last October, in co-operation with the Cocoanut Grove Citrus Growers' Association, and with Mr. Temple, at Winter Park, an investigation of the factors relating to grapefruit storage was begun. The object of these experiments has been to determine whether or not it is feasible to extend the marketing period and equalize the distribution of Florida grapefruit by holding the fruit in storage for some time before

shipment. The work has been carried on throughout the entire season, and there is still a considerable quantity of grapefruit in storage at both Winter Park and Cocoanut Grove. This will be held for at least one or two months longer.

As a further extension of the fruit handling investigations in this State, a preliminary study of pineapple handling and transportation will be begun at Fort Pierce in a few weeks. These experiments will include some fundamental work on the effect of different types of handling on pineapples picked at different stages of maturity—green, just coloring, and fully plant-ripened. The question of shipping pineapples under refrigeration will also be taken up to some extent, and it is quite probable that the work will include careful experiments on the desirability of precooling pineapples.

Blue Mold Decay of Florida Oranges During 1912-1913

Though the experimental work on orange handling was concluded a year ago, the excessive decay in Florida oranges this season makes a brief review of the situation [fol. 365] not out of place. Before taking up the question of grapefruit storage therefore, I wish to devote a few minutes to a discussion of the conditions which seem, in the light of the experimental work of past seasons, to be responsible for the trouble. No extensive experiments have been made with this season's fruit, but a year ago, as you remember, there was a similar period of high decay lasting for about eight weeks. Several experimental shipments, including both carefully and commercially handled oranges, were made at that time. This year Mr. Ramsey made a trip to Florida about February 1st at the request of the Florida Citrus Exchange, and visited several of the orange growing section. From Mr. Ramsey's observations and from experiments covering the six previous seasons, the only conclusion that seems possible is that the decay must be due to handling methods and to wether conditions ideal for the development of the blue mold fungus.

This has been an unusual season in so far as weather conditions are concerned. It has been unusual also in that Florida has shipped the largest crop of oranges and grape-

fruit in the history of the State. To the combination of these two factors the high percentage of blue mold decay can be directly traced. There was, first, an unusually large crop, which meant crowding the packing houses beyond their capacity, and which consequently resulted in a let-down in care in both field handling and packing house operations, followed by a high percentage of injury to the fruit; secondly, temperature and humidity throughout the greater part of the shipping season were relatively high. One factor furnished the soil blue mold spores require, and the other the most favorable conditions for their germination and development. The decay that followed will appear again every time the same conditions arise.

Just how unfavorable the weather conditions were during the shipping season can be plainly seen from the accompanying table. The data given are for the section [fol. 366] around Miami, but they are an indication, at least, of what the conditions were in other parts of the State.

TABLE I.—Number of days each month, from November 1st to March 31st, on which there was a rainfall of 0.1 inch or more, Miami, Fla., 1898-1913

Season..	'98 '99	'99 '00	'00 '01	'01 '02	'02 '03	'03 '04	'04 '05	'05 '06	'06 '07	'07 '08	'08 '09	'09 '10	'10 '11	'11 '12	'12 '13
November ...	2	3	—	—	5	3	8	9	5	7	3	1	1	18	7
December ...	3	5	—	3	1	0	2	7	0	4	3	1	1	11	7
January	6	6	—	0	7	2	2	7	2	8	9	3	2	16	11
February ...	4	4	0	2	4	2	2	6	1	3	0	1	0	6	7
March	3	6	3	0	7	4	3	5	2	4	3	2	4	11	14
Totals	18	24	3a.	3b	24	11	17	34	10	26	18	8	8	62	46

(a). February and March only. (b). November not included. Average number of days per month with one-tenth inch or more rainfall for above period, 4.4.

We may speak of weather conditions, and the fact that blue mold spores are always present in the atmosphere, as causes of decay, but the extent to which these factors can be controlled is limited. Fortunately, however, there is one preventable cause, which, in so far as the grower and shipper of citrus fruit are concerned, is the primary cause. This is the injury done to the fruit in the handling operations from the tree to the car. Blue mold has not the power to penetrate the sound healthy skin of citrus fruit. This fundamental fact has been stated and demonstrated

many times, but it needs to be repeated until it is part of the creed of every man engaged in handling the fruit. Conversely, injured fruit is almost certain to develop blue mold under high temperature and moisture conditions.

The wonderful improvement in packing house equipment and handling methods during the past three or four years has eliminated to a large extent the injury formerly done by crude and antique machinery. Improvement in field handling has also been great, but it is a fact, nevertheless, that it has not kept pace with that in the packing house, and in [fol. 367] some instances has been so poor as to entirely nullify any benefits that might be expected from improved and expensive house equipment. The very best equipment and management can not prevent the decay of fruit already injured in the field, and it is in the field, I think, that most of the trouble during the season just past had its origin.

I regret very much that I have not available the data on field handling which Mr. Ramsey obtained this year. However, these figures show surprisingly poor work, even among the picking crews of the most up-to-date houses. In some cases the percentage of injury and of long stems ran as high as 85 per cent. of the fruit picked. This includes only visible injury, and oranges picked with stems long enough to injure other fruits, either in the picking boxes or while going through the washers and sizers. It was found also that a great deal of harm was being done by dropping the fruit into picking sacks and field boxes. Mr. Tenny, when he had charge of the Florida work, made several experiments on the injury caused by dropping otherwise sound fruit a distance of from one foot to twenty inches. He found that on the average, 20 per cent. decay developed in this fruit after it had been held for two weeks in the packing houses, and I have seen instances where 60 per cent. decay developed from this cause alone. It is reasonable to suppose that the fruit this season was particularly susceptible to this type of injury, since it was grown under conditions favorable to rapid growth, and was very heavy and juicy. More attention should be paid to eliminating unnecessary dropping of the fruit both in the field and packing house. Most picking foremen and pickers realize now the damage caused by clipper cuts and long stems, but there are many who do not know that as much or more decay may be caused by dropping the fruit from one to two feet. This

point is especially important because it is always the weakest point in field handling. It is the first place where lack of care shows. If a picker is rushed, or careless, he at once begins to begrudge the extra moment it takes to empty a [fol. 368] sack of fruit carefully, and if not closely watched it is not long before he, and the rest of the crew as well, are pouring the fruit from their sacks in the approximate direction of the field boxes. There is no place where a bad example is more quickly followed than in a picking crew.

When there is an unusually large crop, or when shipments are unusually heavy, as happens in the annual rush for the Christmas market, it invariably follows that much less care is taken in handling the fruit. This has been found to hold true in citrus fruit handling in both Florida and California. It has held true again this season. There are, of course, individual exceptions to this general rule, and it is encouraging to note that there were some conspicuous exceptions in Florida this year. The packing houses which made a record under this season's trying conditions handled different types of fruit, grown on different types of soil. They used different types of packing house equipment, but there was one factor which was common to all of them—they were all getting consistently careful work in the field.

There are two packing houses located about a hundred miles apart which can be taken as examples of the conspicuous exceptions I have mentioned. The first has held for the past four seasons the enviable distinction of having the best picking crew in the State. Inspections of picking crews covering practically all orange and grapefruit sections have shown the work done by the crew supplying this house to be unquestionably the best. This house has shipped oranges throughout the entire season with no cars showing heavy decay, and only a very few showing even a slight amount. By far the greater part of their shipments arrived on the market with absolutely no decay at a time when, in shipments from other houses, 20 per cent. was the rule rather than the exception.

The second house has not been one of the leaders until this year. Its record at the beginning of the present season was not the best. This apparently put the management on [fol. 369] its mettle, and a consistent and successful attempt was made to improve conditions. During the period of

heaviest decay this house shipped car after car of fruit under ventilation and had it arrive on the market in sound condition. At the same time, other packing houses having equally good equipment and handling equally good fruit, were getting returns showing from 10 to 30 per cent. decay. When I visited this house the first of March, I found one of the best organized and managed picking crews in the State. There is no doubt that the secret of their success lay right there. This, of course, does not discount the value of careful and efficient management in the packing house.

In 1911 the Bureau of Plant Industry was called upon to investigate heavy decay in California oranges arising under conditions similar to what have been experienced in Florida this season. That is, there was an unusually large crop of fruit, resulting in over-crowding the picking crews and packing houses; and warm, rainy weather prevailed during the shipping season. Work on orange handling had been carried on in California previous to this, having been concluded in 1908. A large number of supplementary experiments were made in 1911, and it was found, as has been demonstrated in the Florida work, that carefully handled, uninjured fruit kept in sound condition under the most adverse weather conditions. It was also found that in the rush to get the fruit on the market there had been a serious let-down in care in handling. The conditions in Florida this season seem to me almost an exact duplicate of those in California in 1911.

In summing up the results of this California work in a circular of the Bureau of Plant Industry, Mr. Stubenrauch said: "The industry must always be prepared to meet the exceptional and the unusual." The Florida citrus industry this season has had to contend with exceptional and unusual conditions, and in most cases has tried to meet them with the usual, or a little poorer than the usual, methods. We cannot tell when such conditions will arise again, but they [fol. 370] will arise sooner or later. I believe the remedy lies in recognizing what these conditions mean, and in exercising exceptional care in all handling operations. If necessary, cut down the output of your packing house one-half during a period of high decay, but see that every orange you ship is handled carefully all the way from the tree to the car. Unless absolutely necessary, and unless thorough

drying can be obtained, it is advisable not to wash fruit during warm, humid weather.

There is abundant evidence in support of the statement that carefully handled uninjured fruit will keep under the most unfavorable conditions. It has been demonstrated by repeated experiments in both Florida and California, on thousands of boxes of fruit from all the orange growing sections of both States. But even more convincing and encouraging is the fact that packing houses in Florida, as well as in California, have been able to handle oranges carefully on a commercial scale, so that no matter what the weather or other conditions may be, their packs will arrive on the market sound.

Grapefruit Storage

The grapefruit storage investigations which were begun this season include a study of the keeping quality of fruit picked at different stages of maturity, of the conditions best adapted to the long storage of grapefruit and of the changes which occur in the fruit itself during the storage period. For the purpose of securing a uniform grade of fruit for the experiments, a block of trees, as nearly as possible representative of the average grapefruit groves in each section, was selected at both Winter Park and Cocoanut Grove. The fruit for storage was picked once a month from these trees. In both places insulated storage rooms were constructed and equipped with ventilators, which were opened at night and closed early in the morning. Part of [fol. 371] the fruit is stored in these rooms, and part in storage tents such as are used in California for holding lemons. Hygrothemograph records of the temperature and humidity are obtained in the storage rooms and tents, and for the outside air. The fruit is inspected each month, the amount of decay and shrinkage noted, and a record made of the color, condition (i. e., firmness) and texture of each individual grapefruit.

The results of one year's work can only be taken as a general indication of what it will be possible to accomplish. Although the results this season are, on the whole, encouraging, the question of grapefruit storage is still strictly in the experimental stage, and it is impossible to say at this time to what extent it will be practicable commercially.

The experiments at Winter Park were not begun until February, so a complete season's record is not available for that section. At Cocoanut Grove, however, the first lot of fruit was picked November 8th, and similar lots were picked in December, January, February and March, covering practically the entire shipping season. I shall confine myself, therefore, for the most part to an outline of the work conducted at Cocoanut Grove.

Storage Conditions

The storage room at Cocoanut Grove was built in the basement of the Association packing house. It was constructed with double walls, with a four-inch dead air space between them, double doors and double ventilating shutters. These shutters are opened about 8 o'clock at night, and closed at 4 in the morning. The storage tent is also in the basement of the packing house.

Table II presents temperature and moisture conditions in the storage room and outside air for one week, ending December 29th, 1912. This is typical of the records obtained throughout the season.

[fol. 372] Table II.—Temperature and Humidity Record for Week Ending December 29th, 1912, Cocoanut Grove, Fla.

	Outside Air—Temperature (F.); Humidity %				Storage Room—Temperature (F.); Humidity %			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Monday	82	71	100	83	75	71	84	79
Tuesday	84	70	100	73	70	71	84	80
Wednesday	79	68	96	84	74	71	83	80
Thursday	83	68	100	79	74	69	84	79
Friday	85	62	90	71	74	67	84	76
Saturday	74	57	88	69	68	63	80	71
Sunday	80	71	98	76	72	68	85	72

Conditions in the storage room are decidedly more uniform than in the tent, and conditions in the tent are in turn more uniform than in the outside air. Those in the storage room though not the best by any means, are probably as good as can be expected in this climate with natural cooling. The humidity is still too variable and the temperature too high, however, and it is evident that for the

best results these conditions will have to be modified and improved.

Condition and Quality of Stored Grapefruit

Part of the fruit in both the tent and storage room was stored wrapped, and part unwrapped. Several boxes in each lot of wrapped and unwrapped fruit in the storage room were washed before storage; the remainder were stored without washing. All the fruit held in the tent was washed. Some striking differences in condition were found between grapefruit stored wrapped and unwrapped, washed and not washed, and between fruit in the storage room and that stored in the tent. Tables III. and IV. show how great those differences were. The term "good commercial condition" used in this connection designates fruit that changed very little in color and firmness while in storage. This fruit would not be discounted on the market. What falls outside of this class is not unsaleable by any means, but would have to be shipped under the third grade.

[fol. 373] Table III.—Wrapped vs. Unwrapped Grapefruit. Per Cent. in "Good Commercial Condition" After One to Five Months in Storage.

Length of time in storage	Held in storage room		Held in storage tent	
	Wrapped	Unwrapped	Wrapped	Unwrapped
1 month	99.8	98.1	99.2	70.5
2 months	98.3	91.8	85.2	22.0
3 months	87.8	50.3	27.5	0.8
4 months	79.2	28.0	....	....
5 months	66.4	18.3	....	....

At the end of the first month of storage there was very little difference in condition between the wrapped and unwrapped fruit held in the storage room. At the end of two months, however, the difference was marked, and at the end of five months the percentage of wrapped fruit in good commercial condition was over three and one-half times as great as the percentage of unwrapped fruit. The difference in favor of wrapping is even greater in the fruit stored in the tent. However, the impracticability of holding grapefruit, either wrapped or unwrapped, for any length of time under tent conditions is shown by the table clearly enough to require no further comment.

Table IV.—Washed vs. Not Washed Grapefruit. Held in Storage Room. Per Cent. in "Good Commercial Condition" After One to Five Months' Storage.

Length of time in storage	Wrapped		Unwrapped	
	Washed	Not Washed	Washed	Not Washed
1 month	99.8	100.0	98.1	99.8
2 months	98.3	100.0	91.8	98.9
3 months	87.8	98.5	50.3	78.1
4 months	79.2	96.6	28.0	68.1
5 months	66.4	81.0	18.3	

Grapefruit stored wrapped and not washed has kept in the best condition in all the experiments.

The difference between washed and not washed fruit in storage was surprising. Although handling experiments have demonstrated that fruit not washed is less subject to [fol. 374] decay than that washed, it was not thought that washing would have any effect on the firmness of the fruit after a period of storage. The difference, however, was almost as striking as that between the wrapped and unwrapped fruit. Table IV. shows that after three months and longer in storage, from 11 to 40 per cent. more of the not washed fruit than of the washed, was in good commercial condition. The results shown in both of these tables are an average of the results of all the experiments carried on at Cocoanut Grove this season.

The quality of grapefruit is undoubtedly improved by storage. Analyses of specimens from the different lots, made by the Department of Chemistry of the Florida Experiment Station, show that the citric acid remained practically constant, but that there was a fairly consistent increase in total sugar content. This increase in sugar is 1 1-2 per cent. in the fruit picked in November, after four months in storage, and 1 per cent. in the January fruit after two months in storage. However, the superior quality of the stored fruit can hardly be expressed chemically. Its chief attraction is a mellowness of flavor which makes it even more desirable than the fresh fruit.

Although it has been found possible to hold grapefruit for four months in common storage with over 96 per cent. of it in good commercial condition, there are two factors that must be overcome before it will be advisable to attempt

commercial storage. These are high shrinkage and decay. Shrinkage, that is, loss in weight aside from decay, has averaged from 3 to 6 per cent. a month. It is greatest in the riper fruit, and under the dry conditions which have obtained during most of April. The decay has also increased progressively, and in the grapefruit picked in February and March has been very high. Practically none of this decay has been blue mold, and no stem-end-rot has developed except in a few lots of melanosed fruit. The trouble at Cocoanut Grove was caused by a brown decay which I have never seen before on citrus fruit. Several specimens have been sent to the mycologist of the Bureau [fol. 375] of Plant Industry, and some information will be forthcoming before another season's work is begun. This decay spreads very rapidly by contact; an experiment made at Cocoanut Grove indicates that it may be possible to control it by dipping the fruit in a copper sulphate solution. I am of the opinion, however, that it will not develop at a reasonably low temperature, as very little of it appeared the early part of the season, or in the fruit picked in November, December and January. It seems to be essential that some method be devised to cool the storage rooms to a temperature at least as low as 60 degrees, F.

This has been done at Winter Park for the past month. The storage room there is equipped with an overhead ice room, which will hold several hundred pounds of ice. The fruit in the room is cooled by the gravity circulation of the air chilled by the ice above. This room will hold practically a car of packed fruit, but there are probably not over fifty boxes in it at present. To keep a room of that size and with that quantity of fruit in the neighborhood of 60 degrees, F., requires the meltage of about 100 pounds of ice each twenty-four hours. This amount, of course, will vary greatly under different conditions. As the fruit in storage at Winter Park has only been held for one month under this lower temperature, it is impossible to say now whether or not this method is of marked benefit.

Comparison of Grapefruit Picked at Different Stages of Maturity

Except for decay, there seems to be little difference in the condition of fruit picked in February and March, as

compared with that picked in November and December. The later fruit, of course, has not had as severe a storage test as that picked earlier. At present its condition is slightly poorer than that of the early fruit after a similar period in storage. Part of this is probably due to the somewhat higher temperatures during the last two months, and to the lower humidity during most of the present month. There are two factors with regard to time of picking that [fol. 376] will have to be taken into consideration, if grapefruit storage becomes a commercial practice. The first is the time when the fruit is in the best condition for long storage; the second is the desirability of picking it when it has reached a marketable size. A grower trying to hold grapefruit for a June or July market would naturally keep it on the trees as long as possible. It may be that it will be found advisabe to pick the fruit a month or two before the extreme limit to which it can be held on the trees, in order to get the most desirable sizes; and it may possibly be found that the fruit picked earlier will keep over the longer holding period better than the later fruit can be held for a shorter period.

One season's work can be taken as little more than indicative of the factors which should be considered in planning future work. The experiments will have to be continued at least two more seasons before any definite conclusions can be drawn. We hope, with a continuance of the splendid co-operation given us by Mr. Temple and the Cocoanut Grove Association, to be able to work out the problem to a satisfactory conclusion. The experiments next year will include grapefruit held in storage rooms cooled, either by ice or by artificial refrigeration, to a temperature as low as 60 degrees, F. It will be possible to maintain more constant and satisfactory humidity in rooms cooled in this way. Special emphasis will be laid on this phase of the work, and at the same time the value of certain packing materials, such as cork and sawdust, will be tested. It is hoped that some feasible and practical means will be found of holding Florida grapefruit at least through May, June and July. These three months added to the present marketing period would materially increase the amount of fruit which could be profitably marketed, and the judicious storage of grapefruit should also be of advantage in holding the market

steady throughout the season. It is the opinion of the trade that there would be an active demand for Florida grapefruit at least until the last of July, and I have no doubt [fol. 377] that when the supply is forthcoming the consumer will demand grapefruit every month of the year.

Discussion

Mr. McKay: I have here some specimens of fruit from the storage at Cocoanut Grove. This one was picked November 8th, 1912, and held under common storage. This was picked December 20th, 1912, and held in storage until I came over here. This one was put up wrapped without washing, and this one washed and wrapped. Both were held in the storage.

Mr. Bond: I experimented a little in storage myself in 1893. I shipped something like fifty or seventy-five boxes of oranges to Cleveland, Ohio. As I recollect it now, they were picked about the first of March. They were mixed varieties; I don't remember exactly the varieties. I shipped them to Cleveland and had them put in storage. Later, I went North and went to the storage house and there saw two or three barrels of grapefruit that some one had sent there for their own use—not to sell. I saw the condition they were in, and was told they had been in there about thirty or forty days. My own oranges were perfectly sound. I took them out and sold them to Cleveland people in the month of July. They were packed in boxes and unwrapped and unwashed—we knew nothing about washing them in those days. I think a little of it was done by Mr. Stetson.

My recollection is that my oranges were not wrapped or washed. The result of it was the oranges were perfectly sound. The thermometer was kept in the region of about 40 degrees, so the proprietor stated.

I sold them in different lots, and one man to whom I had sold ten boxes at $4.50 a box, told me that they went down so rapidly you could almost see it. I did not guarantee the oranges, but there was so much complaint that I had to refund almost all the money I received for them. They wouldn't stand any time at all. Those who took one, [fol. 378] two or three boxes for immediate consumption,

I did not hear anything from. I myself took three or four boxes, and we managed to eat them up, though a good many spoiled before we could eat them all up.

We all realize the benefit if we can extend the time, as has been suggested. The only difficulty if they have been in cold storage—and they can be kept there in perfect condition—is to keep them from going down immediately after they are taken out. They will have to be put into a car of practically the same temperature and be used soon after their arrival at the market. At least, that was the result of my experience. You may have learned something since then. This grapefruit looks as though it could be used.

Mr. McKay: I think the gentleman who has just spoken has somewhat misunderstood. We do not propose to hold grapefruit under cold storage. That is an entirely different problem from what we are trying to get at. What we propose to do is to maintain an even, cool temperature, possibly not lower than sixty degrees. The grapefruit you see have been held at a temperature not much lower than seventy-five degrees, and frequently as high as seventy-five. I think the line on the chart shows the temperature to have been as high as seventy-five and as low as sixty-three degrees. Our idea in using artificial cooling is to keep it as low as sixty degrees.

Dr. O. W. Sadler: I have been making a study of this moisture and decay and experimenting a little, too. We have the white fly with us, and consequently have to wash the fruit. I don't know how we can stop it, under present conditions. My observation in the few years past is that under the washing process, there has been no adequate means taken for drying the fruit after it has been washed. I have been in several packing houses this year where they were putting up as fine, clean fruit as could be, but so damp that it wet the paper it was wrapped in, the weather being cold and damp.

Mr. McKay made a remark that if the fruit is kept dry it will not develop blue mold. It is a demonstrated fact [fol. 379] that blue mold will form only where there is moisture. If the fruit is packed when it is moist and shut up in a box tightly so that the moisture is retained, that moisture is going to stay there until the fruit is sold and opened up in the retail stores. In that way, we put our-

selves in a condition inviting decay as perfectly as we can do it.

We have had six years of experiments by experts in picking the fruit carefully, and we are supposed to be sensible enough to avail ourselves of the information gained. We must be ignoramuses indeed if we cannot gain by the benefit of six years' experience, yet we have had excessive decay from blue mold this season.

I have already said that the fruit is not put up dry in the great majority of cases. If I am wrong, I will be glad to have some one correct me. The very best packing houses which had the best reputation last year were putting up fruit wet enough to wet the papers.

I took this matter up with Professor Rolfs by letter. He could not answer all the questions involved to his satisfaction, so he took it up with some one else. He again could not answer it satisfactorily to himself, so he sent it to another—the professor of physics.

Right here, I want to call your attention to this fact: Our packing houses today are run by mechanical dryers. They are run by men who have made a study of mechanics, ignoring the laws of physics. You know that the use of mechanics means force, and force, with oranges, means injury—and decay.

I want to say further, that clipper cuts and injuries of that kind have been considered the sure cause of rot. I tried a little experiment with that, too. After all the good fruit was shipped this year, I went through the grove and found a few culls. I took the best of them and the worst of them and made big clipper cuts, as big as my thumb nail; then I took the long stem and pricked the rind in several places, after washing the fruit. To make sure it was dry, I put it in the oven for fifteen minutes where the woman was ironing. It got so hot I could not handle it [fol. 380] well. Then I wrapped it tight in wrapping paper and packed it up as tight as I could in one of the fruit jar paper cartons, and put newspaper all over the cracks, shut it down tight and put the package away with the fruit still warm.

I left it there eleven days. That is about the length of time it takes to get to Philadelphia or Chicago. Then I opened it up.—There was not a single clipper cut or injured

spot decayed. Some of the spots where I had baked it, had not decayed, either, much to my surprise. The baked part of the rind had sunk down and was as thin as tissue paper, but it had not blue mold decay. Of course it would not stand the pressure of shipping.

Some of the grapefruit I put in there were culls, and most of the grapefruits were decayed, but none of the injured spots—I had thoroughly dried the injured.

The point is, if we can dry the fruit thoroughly, we can prevent the decay that otherwise would take place.

I think we have been led astray by the adoption in Florida of too many California methods. California is so different from Florida. You don't find the moist atmosphere in California. Their physical geography is no more different than the climatic conditions under which their fruit is raised. You don't find mountains in Florida, as in California, in sight of their orange groves. They can easily pre-cool their fruit, because they do not have the same degree of moisture we have here.

The point of my whole talk is, to impress upon you the importance of thoroughly drying your fruit before packing it. Just apply the commonest law of physics. You have a cool orange in a warm room; it will attract moisture just as long as it is cooler than the atmosphere. Now, then, if we pre-cool our fruit to the dew point, we invite moisture. If we put it up dry and put ice in the cars with it, we cool the fruit down to such a point that it will attract moisture from the warmer air outside and will "sweat." If we dry our fruit instead of pre-cooling it, we will not need ice. In [fol. 381] fact, the car that we shipped under ice this season, showed more decay than any other car, shipped without ice.

Failure to dry fruit properly in cold, damp or foggy weather by the methods generally in vogue: On suggestion of O. W. Sadler, Jr., as I have said, I took up the question of the efficiency of heat in evaporating water and the necessary rapidity of movement of the heated air in drying fruit, with the University of Gainesville.

J. R. Benton, Professor of Physics and Electrical Engineering, made the following reply: "It is not difficult to compute how much moisture could be taken up by air at any specified temperature. The best effect would probably be produced by having the air as hot as the fruit would stand.

As an illustration of the story of figures that could be obtained let it be supposed that you start with air at 68 degrees F., completely saturated with moisture; heat this air to 200 degrees F., then let it pass over the fruit and leave the fruit at 86 degrees F. Then one cubic foot of air should carry with it .36 grains of water. Just how much moisture sticks to one orange, I do not know. As a pure guess, I should say about one gram (15 grains), so that approximately three cubic feet of air under the conditions specified would be required for each orange. The amount of heat necessary to warm the air as specified above amounts to 554 calories for each cubic foot, and this would require the burning of .2 of a gram of wood, so that one pound of wood should be enough to heat about 2,000 cubic feet of air if no heat was lost, and should probably be sufficient to dry about 700 oranges.

These computations make no allowance for practical difficulties and imperfections, but represent the best that can be obtainable under ideal conditions."

By what means, then, shall we get the greatest efficiency in thoroughly drying fruit by heat?

In my opinion, there can be no more efficient method than by steam confined in pipes, run close under the rolls carrying the fruit in the drying box. In this way, the heat would [fol. 382] be absolutely under control as to quantity and temperature. A little experimenting in each plant or packing house would soon determine the temperature required for the capacity and speed of the drying box. When this is determined, a thermostat would control that amount automatically, whether the drying rack traveled slow or fast, or not at all, and avoid any danger of "cooking" the fruit, so feared by some.

As per Professor Benton's figures, 200 degrees F. heat would be reduced to 86 degrees F. by the evaporization of the water, so it would be perfectly safe to maintain the heat of the steam in the pipes high enough to secure 120 degrees F. to 135 degrees F. in the drying box, if not more, safely, just short of cooking or scalding.

It would only be necessary to change the air in the drying box after it had taken up all the moisture it would hold at the heat maintained.

The surface of a sphere equals four times the area of a circle of the same diameter. A fruit 4 inches in diameter—80 size—would have 50.26 inches area.

Allowing three feet of air per orange, and an average of 150 oranges per box, and 600 boxes per day, a draft vent 2 feet square would require a draft speed of air of 1.87 linear feet per second, equivalent to the speed of one-quarter mile per hour. Hence, we see the absolute absurdity of forcing heated air over the fruit with a fan at the speed that is done in most cases, under present methods.

The failure of the present method arises from the fact that the air on cold, damp or foggy days is already near the point of saturation, and can take up no more from the fruit, no matter how much is passed over it. Where they use the exhaust heat from engine, or from hot air furnaces, as some do, the heat is so infinitesimal in proportion to the moist air forced through by the fan, it amounts to practically nothing.

From six years of practical experience, it has been thoroughly proved that it is impossible to avoid all injuries from tree to packing house.

[fol. 383] It is also proved by experiment that if all injuries can be dried, free of moisture, blue mold cannot develop.

Therefore, it is my contention that by the use of heat always under full control, we can prevent very much of the decay caused by injuries we can not prevent, and save the growers thousands upon thousands of dollars by primarily preventing decay, and thousands more by saving them from ice bills that cost 15 cents per box.

This being true, is it not criminal negligence to continue the present inefficient means used in trying to dry fruit?

Our motto at Mount Dora is, "We will pack no fruit that is damp. I have carried fruit in my office in the North in May and had it lay until October, because I kept it dry.

Mr. Rolfs: I would like to speak in regard to the analyses of the grapefruit Mr. McKay told us about: The results of the chemical analyses. We should not leave the hall here and generalize on that, because the number of analyses on that were not sufficient to form any general statement in regard to it. The analyses indicated exactly as stated by Professor McKay, but at the same time let us not generalize and say that grapefruit will increase in sugar content as we hold it. Wait until we do some more work along this line before we make a definite statement. We have not yet obtained sufficient data to make a general

statement, but the professor is correct so far as the analyses we have made, have gone.

Mr. McKay: That is a very good point, and I intended to make it clear. The statements made were the result of the few analyses we have made but not enough have been made to enable us to state that it is a definite fact.

Mr. Hubbard: I would like to ask Mr. McKay what percentage of natural shrinkage was sustained by the fruit that was stored.

Mr. McKay: I should say during November and December it was not more than 2 or 3 per cent. However, last month, the conditions were such that it ran up as high as 6 [fol. 384] per cent. The average has been as much as 3 or 4 per cent. a month. The total percentage of the shrinkage of fruit held five months would be about 14 or 15 per cent.

Mr. Hubbard: That coincides with an experiment I made in shipping oranges to England. The oranges were gathered the 15th of October and shipped to my son, and kept in cold storage at Southampton. They were sold the first part of March, and the shrinkage was about the percentage you mention.

Mr. Thompson: I would like to ask in regard to the clipping of the fruit: what kind of clippers; I mean what make is found to give the best results generally over the State.

Mr. McKay: I cannot recommend any particular make of clipper; you want one that does not get out of order easily, with round points, not apt to puncture the fruit, and that can be used with safety and give good satisfaction. (Laughter.)

Mr. Thompson: I do not ask you to give any particular name. I would like to know if different classes of clippers were used in that work.

Mr. McKay: Two or three different kinds. One or two of the better kinds.

Mr. Thompson: I know that is very important. I try to get the best clippers I can find, and yet we have poor enough work. I have not yet found a good clipper, or rather, I should say perhaps in good hands.

Mr. McKay: It is not the clipper so much as the man in charge of the crew. If you have good men with good clippers, kept in good condition, you are pretty apt to get good work.

Mr. Skinner: I would like to know if the Government thinks enough of this to continue the experiments; I mean, the grapefruit storage.

Mr. McKay: They think enough of it to carry it on one more season.

Mr. Skinner: I think the thanks of the Society are due this department, and especially the man who negotiated this [fol. 385] work. I have known about it and watched with a great deal of appreciation the work that is being done. I was greatly pleased, but not surprised, that Mr. Temple, who had already given the department the use of his groves, should go to work and out of his own pocket pay enough for them to continue this work. I think the thanks of all growers are due Mr. Temple.

Mr. McKay: We certainly appreciate the co-operation of Mr. Temple at Winter Park, and, in fact, it has made the continuation of this work possible this season. Mr. Temple paid out of his own pocket.

Mr. Hume: Shall I consider it a motion, Mr. Skinner, that the thanks of this Society be tendered to the department and to Mr. W. C. Temple?

Mr. Skinner: Yes, please consider that a motion.

Motion seconded and carried.

Mr. Hume: The motion has been carried that the thanks of this Society be tendered to the Department of Fruit-Shipping Investigations in Florida, and to Mr. William Chase Temple for having made this work possible. Mr. Secretary, you will please attend to it.

Mr. Carroll: Speaking about clippers: I don't think the instrument is so much to blame for the injury done to the orange. Don't you think it is the man at the other end of the clipper more than the instrument itself?

Mr. McKay: Yes. I have seen cuts made with the best clipper. I have also seen practically perfect fruit turned in by men with poorer clippers, but doing good work.

Mr. Carroll: It has been my experience that injury to the orange is caused more by the man than the clipper. I have found that men who were careful had far less mechanical injury, under less advantageous circumstances.

I was greatly impressed not long since at a grove in this State where I went to see the gentlemen who owned it. I could not find him, and at first could not find anybody, but

I soon located them. I could hear them pouring oranges [fol. 386] into the field boxes at least two hundred yards away. Of course that would not hurt an orange(?).

Mr. McKay: No, not if you eat it right away.

Methods of Packing and Shiping Citrus Fruits

H. B. Stevens

Mr. Stevens: MR. PRESIDENT, LADIES AND GENTLEMEN: I think it is rather out of order to call on this committee after bearing such an address as we have had on the same subject. It seems as though we can add nothing, and what we may have to say will fall rather flat after listening to such a fine talk as that was.

I presume I was given this subject so that I might offer such suggestions as I though would help the grower to get his fruit to market in the best condition. In order to do that one must begin earlier than the packing house. The grower must know his fruit.

If he has some that he knows are delicate, and likely not to carry well, then he should so fertilize that part of his grove as to make the skin a little tougher. If he has a variety that does not carry well late in the season, then he should ship that earlier.

Then the greatest care should be taken in the picking and handling of the fruit, from the tree to the car, all along the line.

First. Have such clippers as will give the best results in cutting the stem close, and not injure the orange.

Second. Have baskets lined with cloth, so that the fruit will not get bruised in being placed in the basket, nor jammed by coming in contact with tree or ladder.

Third. Do not allow the picker to empty his own basket, but have a special force to do that work, so he will not be tempted to pour his fruit out of his basket, when the boss is not around.

Fourth. Have your wagon so constructed that you can haul your grove boxes without putting one box on top of another.

[fol. 387] Fifth. Have springs of some kind to take the jar off your fruit.

Sixth. Have no ventilator cracks in your field boxes except at the bottom corners, so your fruit will not get pressed into them, and so receive injury enough to permit the rot germ to find lodgment, but not enough injury to attract the attention of the grader.

Great care should be taken in feeding the fruit to the washer or sizer. I visited a packing house this winter and saw them grading tangerines; two men were emptying filled boxes into the hopper that supplied the grader. They piled the fruit so high that finally they had to put a full box on top of the pile to empty it. I thought, what is the use of putting tangerines in trays to make them carry well if they would stand all that. All fruit should be shipped as soon as possible after it is picked, for the fresher you can get it to the market, the better your trade will like it.

Fruit may be picked even when the trees are wet from rain or dew, if care is taken not to allow them to stand long in the field boxes, while damp. If they are washed and dried right away, no harm will be done by their being picked when damp.

I think more attention should be paid to the grading of the fruit, as it is very difficult to correct a mistake after it has passed the grader. There should be some system by which a check could be kept on the grader, so that you could prove that he is the one who made the mistake; then he will be more careful than he will if it cannot be traced to him. The grading is much more important than the packing, as it requires closer observation and attention to business, while packing is more mechanical.

If the boss picker does his duty in seeing that the stems are cut as they should be, and the fruit handled right from the tree to the house, and the grader does his work as it should be, and the fruit is loaded properly in the car, there will be little complaint at the other end. But the best [fol. 388] packer in the world can not overcome the damage done in the grove, nor discover all that has slipped by a careless grader.

L. B. Skinner

Mr. Skinner: I had intended making a short history of the packing house methods that I have seen since I went

into the orange business, nearly thirty years ago. There has been a great evolution (or should I say revolution?), undoubtedly. But I have had so much to do that I could not prepare a paper, and relied on my friend Mr. Stevens to give you the written report.

However I want to emphasize one or two things in regard to this question of packing fruit by up-to-date methods.

Dr. Sadler has struck the keynote. Dr. Sadler's remarks, in my opinion, go to the root of the question. I do not entirely agree with the cooking of the orange, and the conditions caused thereby are entirely different from what we have to deal with, and I do not think that goes to prove much that will help us, because the anti-septic conditions caused by the intense heat cannot be applied to our packed oranges. But I do think that it is absolutely necessary to get the fruit thoroughly dry—absolutely essential. I don't think I quite agree with him that pre-cooling the fruit is a mistake, because I think the scientific experiments in Washington far outweight the single car they shipped under refrigeration. Their statistics are accurate, and the list of them, added up and a balance struck, tell the story.

The professors say that the remarks made about the grapefruit developing a little more sugar after the fruit is picked, will not do for us to state as a fact, but I tell you it is mighty pleasing to feel that probably it is true.

I think that the injury is in the field—largely in the field. Mr. McKay has been at my packing house a number of times, and Mr. Ramsey, too, and Mr. McKay and Mr. Ramsey have been in the field. They have become acquainted with my foreman and my inspector and gotten them interested. They have gotten them to feel that their part of the work is absolutely essential, and when the inspector brings in his report to me, as he goes over each man's boxes he can give me a report of the number of clipper cuts, or long stems for each man. He is interested, and interested in the result, and if you can get your foreman and your inspector and your men interested, you are going to win, and if you do not get them interested, you are going to lose.

[fol. 389]

Mr. Temple has been a great disciple of this careful handling, and I have not the slightest doubt that he gave orders to the foreman in his groves that every care should be taken this year, and if their fruit was decayed, there was bad handling in the field. That is the whole secret—get your men interested, get them to realize that careful handling on their part is the secret of the whole thing.

I remember one experiment in a washing machine at Largo here the department made an experiment. The washer rolled the tangerines until the pulp inside was separated from the outside rind. You would think they would rot, but those tangerines kept a wonderfully long time. They were thoroughly dried after they were washed, and I think that was the whole secret.

Sometimes we do not know how things are going to turn out; something happens we don't look for, but we do know that if we handle the fruit carefully, and exercise care through every process, we have every chance to win; but if we handle it roughly, we have every chance to lose.

One or two experiments have been made this year, I think the first time accidentally, in pre-cooling fruit in this State; that is, there was a car, iced, placed during the decay period; I mean, there was a good deal of ice remaining in it that came down from the North; not especially placed as an ice car, but a refrigerator vent. The gentleman I speak of made up his mind to try an experiment, and put all the ice in the front bunker of that car and shipped it [fol. 390] under ventilation, and he told me the best results came from the fruit carrying in that pre-cooled car. I think if we pre-cool fruit in this State and get it out of the State in twenty-four hours, they generally by that time reach a temperature that would keep it cool enough. Of course, this past season it was as warm in Washington as in Florida, almost, and the same conditions prevailed in both places. I was in Washington during the decay period in January. I was present when fruit was taken from the cars apparently perfectly sound. In twenty-four hours over half *half* of that fruit had decayed, and in three days hardly any of it was left. Professor Ramsey told me he had gone to a store and bought a dozen oranges, and before they could be eaten half of them were gone. I asked Professor Ramsey to come and look over with me the oranges

which were arriving. We looked them over and found blue mold decay.

That comes back again to the fact that the fruit must be injured or mistreated; if not by us, by the people who open up the boxes in the North.

I have made a good many experiments with this matter of drying, and have felt that the result of those experiments is that we have to raise the temperature of the air in order to get this fruit dry enough to prevent decay. There are others who feel that if we reduce the temperature of the air and cool the fruit, it would be better. The results obtained this year at our packing house have been fine, and were gained by heating the fruit probably eight or ten degrees higher than when it came under the fans, and getting it absolutely dry.

If you take a glass and look at an orange as ordinarily dried, you will be more than likely to find infinitesimal spots of moisture in the pores of the rind, even though it seems perfectly dry. This is far from being dry.

As I said before, I think Dr. Sadler has struck the keynote. The point is to get your fruit dry, if you have to wash it.

[fol. 391] Discussion

Dr. Sadler: I am very glad, Mr. Skinner, that you have been able to reach the same conclusions as mine. I have been sure for some time that I was right on principle. I would like to know if this is of value, especially to the Experiment Station, that it may be taken up in a scientific way and worked out to a conclusion. If we can only prove it, prove that fruit thoroughly dry will go through to the market what we can save on ice bills:

Here in Florida it is impossible to dry the fruit on some days. I have seen days when the air was absolutely saturated. You might blow all the air in Florida over that fruit, and you couldn't dry it. The temperature must be raised and our packing houses equipped so that we can dry it under all conditions.

Mr. Skinner: The question of refrigeration has been brought up, and the expense of it. I suppose some of you are aware that we are paying about twice as much for re-

frigeration as we ought to pay. Refrigeration charges are in the neighborhood of $50.00 to $75.00 per car. Refrigeration on vegetables is a good deal less. There is an effort being made to get this refrigeration charge reduced. At the Tampa meeting of the Orange and Vegetable Growers, this league was formed. One of its purposes is to help growers get the money out of their stuff whenever it is possible. You see, I am advertising right now. I am advertising the League. We are trying to get together a number of shippers to make this thing a success. The cost is not much: Only $1.00 for each member and an assessment of 25 cents on each car for all of the product shipped. It looks [fol. 392] like a little amount of money, but if everybody would come in and do their part, we will probably be able to do our part and save $25.00 or $30.00 a car on every car shipped. It is time for everyone to help. It is not my business, nor any one person's business, but the business of all of us. You ought to help organize the League, because with your earnest support it can save you lots of money.

Take the Florida Shippers' Association; it is a very small Association; just a few men, and yet they have saved this State over a million dollars since it was formed. There is no telling what this League can do if supported by the growers of this State.

Mr. J. H. Sadler: I know men who ship out oranges under refrigeration who believe it is the cure for all evils. They handle their fruit in a more or less careless way in their groves, but think that by shipping it in an ice car it will get through in good shape. Now to my way of thinking, that is a mistake.

We are trying to settle that difficulty in my neighborhood and my Association—if I may call it that. We are trying to get at the point by careful handling. During the months there was the worst decay, we reduced our decay down to 2¾ per cent. We did that by careful handling in the field. We worked every scheme possible to get it properly picked; we washed it and got it dry. When we first started out to do this washing and drying proposition, we made an absolute failure. Our machine did great mechan-

ical injury, so we tried drying it in the sun. If the sun shone, the fruit was dried, and if it didn't shine the fruit did not get dry. Yet we got good results on account of the careful handling of the fruit. Now, we have machinery and appliances that give us the results I have mentioned. [fol. 393] Away back in the early history of the country, we had a cheaper freight rate than we have now. The point of the whole matter is that our commodities cost so much more to market now. I think the icing business is a mistake, in some ways.

I remember the time when tomatoes were shipped in a plain pine box, sawed out right there, and our stuff went into the market, not very attractive, but it brought the top of the market. Some smart, progressive man came down and brought in a car of crates, the kind that has since become the standard. I think the price was about 40 cents apiece, as against 7 cents for the other kind we had been using. They were fixed up mighty nice, and when they were shipped they brought about $1.00 ahead of the market. People went crazy over it, and every fellow was going to be a little smarter than his neighbor, and everybody had to use them. It just about trebled the cost to get our product put up.

So far, we seem to think that we can solve all our difficulties by simply spending money. Mr. Temple is a great advocate of careful handling; Mr. Temple is correct, too, but I think if our business is to stay alive and be a success we have got to come down to consider the matter from an economical standpoint. It seems to be customary to settle everything in some expensive way. The extravagance is alarming, and we have no way to stop it, it seems. I have had to settle the greater part of my difficulties economically. Now, if we can only prove that if we handle our fruit carefully and pack it carefully, and save that icing expense of $60.00 or $70.00, think how much it will save us. As I said before, I believe the icing question is a mistake. I am, of course, strongly inclined to think what Mr. Temple says is all right, but when he advocated this icing so earnestly, it [fol. 394] was all I could do to keep from going into the question in print. The whole question can be solved in some other way, and it should be done.

Mr. Carlton: There is no doubt but that refrigeration is practically prohibitive. Since a good many of us have to depend on ventilators, I would like to ask if in your opinion the ventilated cars are adequate. It is my experience that there is nothing that can remove the moisture better than thorough ventilation.

I think a good deal of criticism could be brought to bear on our packing houses, too. In many instances our packing houses are kept closed almost air tight, from twelve to fifteen hours every day, the doors being opened only when the fruit is being packed. We should have ventilators that are arranged to keep currents of air moving over our fruit as much as possible. That will remove moisture more than anything else.

Mr. Thompson: I just want to say one word in regard to refrigeration. We have had a little experience at Florence Villa, along the line of refrigeration, in that we felt that was the panacea for our troubles, and from an experimental standpoint. We put some cars under refrigeration and shipped them at the same time we shipped other cars without refrigeration. The result in the market was not in favor of refrigeration any more than the other. That has been our experience and so far as our packing and ventilating the cars; we always strip our cars; that is, a space of six inches is left between the boxes for the air to circulate freely over them. We washed all of our fruit and dried it with a mechanical dryer. It would be impossible to do it in any other way. We find our fruit more attractive if it is clean, and while it is not absolutely dry, yet we shipped last week an average of five cars a day, and we fixed it up in that way.

[fol. 395] It is rather a difficult proposition to dry in the sun. It cannot be done at all times successfully.

We have had not over 1 per cent. decay. I think that is a pretty fair record.

Mr. Ley: I would like to go back a few years from where this gentleman, Mr. Skinner, started a few moments ago I think, he said he had been shipping a period of thirty years. My shipping ended almost at that time, and I had quite a little experience in gathering and shipping ac-

cording to the old way. In those days, such things as poor carriage was unheard of.

Our method of gathering fruit was that followed by three boys. An orange tree of that time was no more thornless than they are today; notwithstanding that, one boy would get into the tree and throw the fruit to the one below, who would drop it on the sand. We didn't have only about 200 or 300 barrels in those days (the square box was unknown), and we had no wraps, and I believe the secret of its keeping qualities was in the drying process. The sand where the fruit was dropped was hot: so hot that it would almost blister our bare feet, and there was no moisture left on the rind of an orange that had lain there a few minutes.

Of course, we did not gather oranges when it was raining; always when it was dry, and when it was dry weather at Micanopy it was maybe raining at Ocala or Gainesville so they could not gather them there, and we would have an open market for the Micanopy fruit.

Then the barrels were carried into the groves and little holes were jabbed out for ventilation, and we put the oranges in those barrels absolutely dry; those small pores even were dry, and we put them in the barrels, without sizing, of course, for we knew nothing about sizing, either, in those days, and shipped them all from the size of a hickory nut on up. We hauled the fruit into town in a wagon without springs, and got a pretty fair price, too.

[fol. 396] I merely want to emphasize the point that the fruit left our groves absolutely dry, in good condition; it carried well and sold at satisfactory prices. I firmly believe, sir, the main point in the shipping fruit question is to see that it is dry. I have always had my doubts about the benefits of wrapping the fruit, for I should think it would prevent the contact of air with the surface of the orange.

Mr. H. B. Stevens: I want to emphasize the point of handling fruit under the check system. We keep a check on it from the time it is gathered until it gets in the car. I find it well for each man to lose his identity and be known by a number. A record is kept of each man's faults, not known except by number, by the men who have charge of the picking, and if it escapes them it comes to the carrier wagon, which can carry thirteen boxes without putting one box on top of another. It comes to the washer, and if he

sees anything wrong he immediately marks the number on the box. A copy of the list is kept for me. The next morning I take this list and look it over. I don't know who the man is, but there is the full record: "Number So-and-So has picked so many hours, so many boxes, so many complaints lodged against him." If his faults are bad and he cannot or will not correct them, we tell him he must look for another job. If the complaints grow less I commend the men for it before the whole crew, and they very much appreciate the compliment.

We pay by the day—not by the box.

This year we have not shipped a single car under ice, and we have not stripped a single car, although I do not object to it, but I so loaded my car that it can be thoroughly ventilated. It is loaded so that the heated air which rises to the top is carried off by the motion of the train. We have had complaints about one or two cars which showed a little decay.

Up to January 1st, we had only one refrigerator car. We could not get refrigerator cars. After January [fol. 397] 1st we had the common refrigerator and, as I say, we have had but little complaint the whole season through.

Mr. Pierce: Fifty years ago, when I was a young man, the orange crop in Polk County had to be hauled to Tampa by team, sometimes as much as forty-five miles. We could not get empty barrels in those times, and so we would use pine straw, if we could not get hay, and put it six or eight inches thick in the bottom of a wagon and dump the oranges in and haul them to Tampa, then dump them into the hull of a boat, and they went to market that way. Some of us got results from it, and some of us didn't. We carried them to market that way, rain or shine. A few freight teams were pretty well fixed up; some had covers, and some didn't.

I am glad to see you people are leading in the discussions we are having, and you are going to have success, but you have to consider natural circumstances. You cannot do away with them; you cannot avoid them. Natural conditions are going to prevail. I am a Cracker, I know, but I have had fifty years of experience, and I am willing, climatic conditions being the same, to take a piece of land side by side with the scientific men, and go into any kind of a test with

them. I can do just as well as they can when it comes to getting things out of the ground. Experience and science are good things, and it is a good thing to mix them. Each works better with the other than it does alone.

There have been some big things to happen in the last few years in the orange industry. The last few years have seen the big commercial enterprises, and then people are beginning to see the relation between consumption and production. Then we are beginning to see the relation between producer and consumer. Gentlemen, we all know the fluctuation of a market when some man in New York or Washington, sitting behind millions of dollars controls it, and we know there is something else at work besides consumption and production.

Mr. ——: Did you pull those oranges, or did you gather them?

[fol. 398] Mr. Pierce: We pulled them. If they came off easily when it was pulled, it came off.

Mr. Hume: I will have to call time, I think, and ask if there is any further discussion before we go on to the next subject.

Mr. Pierce: Well, maybe I will get another chance before the meeting ends.

Mr. Bartlett: I have shipped oranges out of this State since 1883 to the time of the freeze of '94 and '95. Like the gentleman on my right here, I, too, have had a little experience along that line. We had the same trouble then with the rot that we have now. I myself went to Cleveland, Ohio, in 1885 and 1886 and bought oranges. I went to the warehouse and sorted them over. I sorted out four or five boxes before I got two boxes.

On the other hand, I have seen oranges shipped in bulk to Cleveland that went in sound condition. I endorse most emphatically all that has been said by Mr. Skinner and other gentlemen in regard to having your fruit dry. My experience bears out theirs.

I picked oranges this last year in the rain, but they got dry. Some of them reached the market all right, and some did not get there. They were put through a washing machine.

I used to make orange boxes myself with a saw, and I think I have the honor of bringing the first veneer mill into this State that made orange boxes out of pine logs.

I think we cannot put too much emphasis on the point of having the fruit dry. In those days we did not wrap, but sometimes they go all right one way and sometimes another. Sometimes we get a big price, and sometimes we don't. When our doctors disagree, what are we poor laymen going to do? We must use our own judgment.

[fol. 399] PLAINTIFF'S EXHIBIT No. 24

BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE
No. 63
Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.

Factors Covering the Successful Shipment of Oranges from Florida[1]

By A. V. Stubenbrauch, Pomologist and Horticulturist, H. J. Ramsey, Pomologist in Charge of Fruit Transportation and Storage Investigations, and Lloyd S. Tenny, formerly Pomologist in Fruit-Transportation Investigations; assisted by A. W. McKay, B. B. Pratt, C. S. Pomeroy, K. B. Lewis, G. M. Darrow, Margaret Connor, and J. F. Fernald, of the Office of Horticultural and Pomological Investigations.

---

[1] Report on harvesting, handling, and shipping experiments made on a commercial scale through seven shipping years, showing that decay can be materially lessened by greater care and the avoidance of mechanical injury to the fruit.

Introduction

The citrus-fruit industry of Florida is preeminently first among the agricultural and business interests of the State. According to the figures of the last United States census there were 3,864,514 orange trees in the State in the spring of 1910, 2,766,618 of these being of bearing age and 1,097,896 nonbearing. The yield of the 1909 orange crop, as given by the census of 1910, was 4,852,967 boxes, valued at $4,304,987. From the best sources obtainable at the present time,[2] the citrus crop of Florida during the season of 1912-13 amounted to 28,428 carloads, or 8,125,465 boxes, of which approximately 5,769,079 boxes, or 71 per cent, were oranges; approximately 2,031,367 boxes, or 25 per cent, were grapefruit; the balance, of approximately 325,019 boxes, or 4 per cent, being tangerines, kumquats, and limes.

During the winter of 1894-95 there occurred in Florida two very severe freezes, which wrought great havoc in the groves of the State and permanently changed the character of the citrus industry. Present conditions date from that season to a great extent. According to Hume [3] there were 5,055,367 boxes in the crop of 1893-94, and the output for the following year would doubtless have reached 6,000,000 boxes. Exceptionally low temperatures, interspersed with periods of warm, growing weather, proved fatal, however, and a large number of trees were either killed outright or had practically all of their bearing wood destroyed. Instead of 6,000,000 boxes, the crop of 1894-95 was reduced to 75,000, as a consequence. It will be seen, therefore, that so far as production is concerned, the Florida citrus industry is now just regaining the position which it held at the time of the freeze of 1895.

Location of the Florida Citrus Industry

Previous to the freeze of 1895 the citrus industry of Florida was largely centered in Lake, Orange, and Marion

---

[2] These figures were furnished by the Florida Citrus Exchange.

[3] Hume, H. Harold. Citrus Fruits and Their Culture. Jacksonville, Fla., 1904, p. 4.

Counties. After the destruction or serious damage to a large number of the best groves in these sections some of the owners became discouraged and either went north to [fol. 400] engage in other enterprises or sought locations for their new groves farther south, where conditions were considered safer. Since many of the older groves have been reestablished, the industry has become widely scattered over the State. Plantings now extend in a narrow fringe along the east coast, from St. John County on the north to below Miami, in Dade County, and along the west or Gulf coast they reach from Citrus County almost to the southern boundary of Lee County. Extensive plantings extend diagonally across the State from Volusia County on the east to Hillsboro, Manatee, De Soto, and Lee Counties on the west, including large sections of Brevard, Orange, Lake, Sumter, Hernando, Pasco, and Polk Counties, in addition to those already mentioned. Sections in Marion, Alachua, Citrus, and Osceola Counties also are devoted to citrus

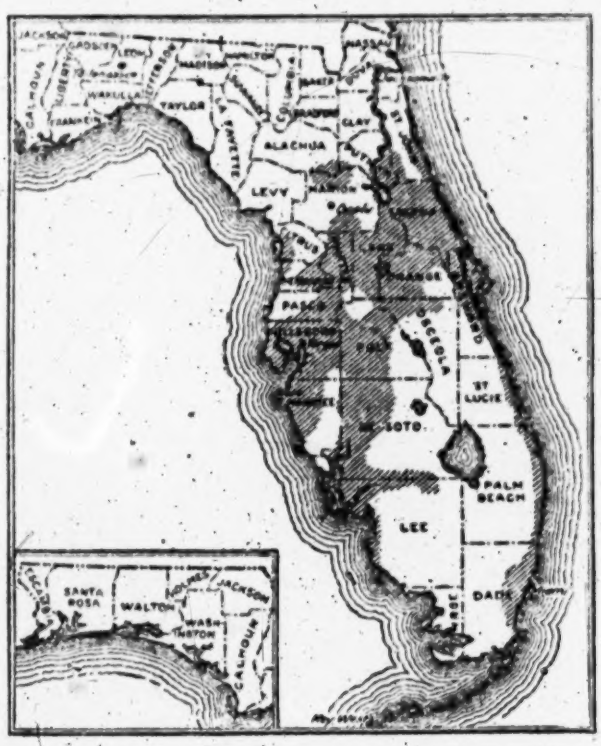


Fig. 1.—Map of Florida, with the location of the principal citrus plantings indicated by shading.

fruits. Figure 1 shows a map of the State with the location of the citrus plantings indicated by shading.

The difficulties of handling and marketing crops of fruit produced in groves scattered over so wide a territory are manifestly greater than where the plantations are confined to a more restricted territory. Where groves are located comparatively close together, as was the case in many of the older citrus districts of Florida, a neighborhood competition is stimulated, especially in the production of clean, bright fruit of fine texture. There has probably never been a region where so many varieties of oranges have been developed and tested as in what, before the freeze, were the old neighborhood centers of production, or where more strenuous efforts have been made to produce fruit of fine texture and flavor. Moreover, a special effort was made to pack the fruit in an attractive manner and to have it reach the market without decay. At present, with the groves so widely scattered throughout the State, there is much less personal contact between growers, and the old neighborhood competition in the production of fancy fruit has largely disappeared. Although the industry has become better organized during the last few years, it is extremely difficult to make effective any association which represents so many diverse interests and whose members are so widely scattered. This situation has proved a great barrier to the introduction of better handling and marketing methods.

History of the Florida Citrus Industry

It is believed that the orange was originally introduced into Florida by the Spaniards, who imported a few sour oranges and gave some of the fruits to the Indians. The seeds of these fruits, being distributed from village to village and finding congenial soil and favorable climatic con- [fol. 401] ditions in the hardwood forests and live-oak groves, where the tall native growth protected them from sun and radiation, grew up into seedling trees, and in time formed wild groves of immense extent throughout the northern and central parts of peninsular Florida.[1] Although

---

[1] Mead, Theodore L. The orange. Article in Cyclopedia of American Horticulture, 1901, p. 1154.

sweet oranges were known in Florida before the Civil War, they were not considered of commercial importance because of the absence of transportation facilities. Commercial orange culture dates back to between 1865 and 1870, when the success of the trees along the banks of the St. Johns River began to attract attention to this industry as a good investment. As the profits were large from the first, many were thereby induced to engage in the business, and the industry gradually expanded until in 1895 the production had reached nearly 6,000,000 boxes.

Transportation problems and market conditions have changed considerably since Florida reached its highest point in citrus production before the freeze. First of all, the citrus industry of California has been largely developed since that time. Through the establishment of efficient transportation facilities and modern refrigerator-car service, the California growers have been enabled to distribute their fruit over practically every State in the Union. In the early days of the industry, the Florida orange growers did not have to meet the keen competition which has developed in recent years, and therefore the condition of their fruit upon its arrival in the market did not affect the selling price as much as it does at present. The market demand for Florida oranges was strong, and fair prices were usually obtained in spite of the presence of considerable decay. As the production increased just prior to 1894-95, less favorable prices were being received, and at the time of the freeze efforts were being made to extend the market both at home and abroad and to produce fruit of better keeping quality.

The formation during that period of the Florida Fruit Exchange may be considered as an effort among the growers to obtain better marketing conditions, induced, it is thought, by the necessity of improving the quality and condition of fruit in the markets. Although the Exchange failed to accomplish the special object for which it was created, it did prove that Florida oranges often failed to reach the northern markets in sound condition. Notwithstanding the general impression now current among growers that the decay of oranges was unknown before 1894, it seems to be well established that for many years the fruit has shown considerable waste.

A few reports taken from the current issues of the trade papers will serve to show that even at that time the decay problem was of considerable importance. In the issue of December 23, 1893, of "The Florida Despatch Farmer and Fruit Grower," under the Buffalo-New York fruit-sales letter, a statement was made which is characteristic of many others and serves to illustrate the wasted condition in which the fruit often reached the market. This report reads, in part:

> Very sorry to report that the fruit is still coming forward in poor condition. * * * About 1,400 boxes, good and bad, mostly all of which showed more or less decay, averaged $1.51.

Under date of December 2, 1893, the following report is given:

> The dealers and handlers throughout the country are worn out with the constant labor of repacking, in the effort to save something out of the ruins of the decay, and to save the fruit from going bodily to the dump. Buyers are afraid to take hold, because they have no assurance of getting an article that will hold together until they can get rid of it.

Out of 19 telegraphic reports, 12 mention fruit showing decay, using such remarks as: "Both much decayed," "Some lots in very bad order," "Oranges mostly decayed," and "Very rotten." It will thus be seen that the conditions which are conducive to the occurrence of decay were present in the early days of the industry.

[fol. 402] With the extension of the plantings consequent upon the reestablishment of the industry, and the resulting increase in production, existing conditions have been largely responsible for the improper handling of the fruit, which has been shown by later investigations to be the fundamental factor underlying the occurrence of decay. Many of the new groves established since the freeze have been planted on pine land, where it has been necessary to use heavy applications of fertilizers. Frequently the fertilizers have been selected with the purpose of producing large crops rather than fancy fruit, and this seems to have been at the expense of quality, thus partly accounting for the large proportion of rough and unattractive oranges now to be

found in the Florida crop. The production of large quantities of rather coarse and uninviting fruit has in turn led to rough and careless handling, for, as a general rule, the more attractive the fruit the greater will be the incentive to handle it carefully when preparing it for shipment.

In addition to the freeze, unfavorable conditions have existed which have more or less discouraged many growers and which have led to the production of inferior fruit, with a correspondingly increasing tendency to place it on the market in a manner not conducive to the best results. The control of the white fly, which has spread over practically every citrus district in Florida, has been a serious problem. Fruit which has been rendered unattractive through the attacks of this pest presents one of the most discouraging problems which growers have to solve, for it is difficult to make workmen who pick, grade, and pack unattractive fruit realize the importance of careful handling. The sooty-mold fungus follows the attacks of the white fly, covering the leaves and fruit with a dense black-growth which detracts greatly from the appearance of the oranges, and in order to prepare this smutty fruit for market, cleaning is absolutely necessary. The effects of the cleaning processes upon the carrying quality of the fruit will be described later.

The market demands high-grade, well-packed fruit. As long as the supply of a commodity does not equal the demand, a poorer grade or a less attractive package may yield satisfactory returns to the shipper. With keen competition, however, and markets well stocked with good, carefully selected fruit arriving in sound condition, the packer of a poor grade of fruit which frequently arrives in bad order is at a great disadvantage and suffers accordingly.

Methods of Handling the Florida Orange Crop

The Florida orange begins to ripen in late October or early November, and the shipping season extends until spring, some growers of late varieties even holding their fruit on the trees until summer. Shipments are usually heavy during December, and in the past approximately 50 per cent of the crop has been shipped before Christmas. In fact, there has been a strong tendency to begin moving the fruit before it has reached full maturity. This practice has been stimulated because it frequently happens that

these early shipments give satisfactory returns, and fruit moved at this time runs no risk of being frozen later in the season. The practice of placing on the market large quantities of green fruit of poor eating quality is very objectionable, however, and does not stimulate future consumption of the product.

During the past few years the tendency has been toward lengthening the marketing season. Instead of attempting to dispose of the bulk of the crop before the holidays, when a large proportion of the fruit has not reached full quality, the season has gradually been extended, so that Florida citrus fruits are now moved in large quantities until the first of April, and even later. The influence of these change conditions upon the occurrence of decay and deterioration at the market end will be apparent in the later discussion of the occurrence of decay at different times during the shipping season.

[fol. 408] Picking the Fruit

Harvesting methods.—In harvesting the orange, it is necessary to sever the fruit from the trees by means of clippers or shears, the common type being a sharp-pointed clipper, such as illustrated on the left in figure 2. Various other types are also in use at the present time, two of which are shown in figure 2.

Since many of the orange trees in Florida are large, only a small proportion of the fruit can be reached from the ground. The ordinary straight ladder, placed directly against the tree, is in common use. In order to secure all of the fruit at the top or in the center of the tree, the picker must stretch over a considerable distance, and he is very liable to pull many of the oranges which he can not conveniently sever with his clippers. Worse than this, however, it has not been uncommon to see the fruit on the ends of the limbs shaken off and allowed to drop to the ground, later to be picked up and placed in the field boxes along with the fruit properly handled.

Over the picker's shoulder is thrown a basket or bag in which the fruit is placed as clipped. The picking bag is sometimes an ordinary grain bag or gunny sack holding about 30 pounds of fruit; formerly, some men used a specially constructed bag which fastened around the body and

frequently held nearly enough fruit to fill one of the boxes. The canvas-covered basket shown in Plate I, figure 1, holds approximately half of a box of fruit. Another type of picking receptacle, illustrated in Plate I, figure 2, has a hinged bottom which may be let down when emptying the fruit. The most common bag now in use is one made of heavy canvas and open at the bottom, so that the filled bag can be placed in the box and the fruit allowed to roll out gently.

Fig. 2.—Three types of clippers used in picking Florida citrus fruits.

Field boxes.—The fruit is poured from the picking receptacle into a field crate or box. The box in general use is about 28 inches long, 12 inches wide, and 13½ inches deep, has a capacity of a little more than one packed box of fruit, and may or may not have a central partition. Both types are illustrated in Plate I, figures 1 and 2. The size of this box was established through the practice of buying large quantities of fruit on the tree at a fixed price per box. Originally this price was intended to be per "packed box," but since it is more convenient to keep the record of the fruit as it leaves the grove, this type of field box, which holds enough fruit to allow culling and still give the buyer a packed box of oranges, was developed. Other kinds of field boxes, some of which are superior to the old box, are in use to a limited extent. Plate II, figure 1, shows a type of grocer's delivery crate which some growers use for handling their oranges.

The boxes in common use are constructed of such heavy material and hold such large quantities of fruit that it is

impossible to handle them with sufficient care. When loading them on the field wagon or unloading them at the packing house, or even when moving them about in the house, they oftentimes strike the floor with sufficient force to cause some of the fruit to bound out. The objection commonly raised to making boxes of lighter material is that the workmen will break them by rough handling, especially when throwing them off the wagon in the field. It is a question, however, whether the average laborer will not treat a lighter box more carefully than he will a heavy iron-bound one, which tempts him to see how roughly he can handle it. [fol. 404] Plate II, figure 2 shows that the effort to make a field box strong enough to withstand "bucking" is not always successful. While it is difficult to estimate the amount of damage which may result from the use of such boxes, it is apparent that this is very great.

An enumeration of some of the injuries received in picking will be found under the discussion of the causes of blue-mold decay.

Hauling the Fruit

The fruit is hauled from the grove to the packing house on ordinary farm wagons, which are often springless, or on specially provided wagons belonging to an association. The owner of the grove or the manager of the packing house sometimes personally superintends this transfer, but frequently it is done by contract with the owner of a livery stable. There is usually a fixed price for this service, one large contractor receiving 2 cents per box per mile, which is about the average of what is paid in different parts of the State. The drivers are often ignorant of the importance of careful handling, and their methods of loading and unloading are extremely crude and rough. It is not uncommon to see them sitting on boxes of fruit as they ride to the packing house. The haul may be long and over rough roads (Pl. III, fig. 1), some packing houses handling many boxes of fruit from groves 12 or 15 miles distant, or even farther. Ox teams are often used for such long hauls (Pl. III, fig. 2). It has even been the custom in the past, to carry many oranges loose in the wagon box, the unloading being done with shovels or in other rough ways (Pl. IV, fig. 1). This practice has been done away with, however, as it is recognized that good results can never be obtained by such

FIG. 1.—EMPTYING ORANGES FROM A PICKING BAG INTO A FIELD CRATE, SHOWING AN INCORRECT METHOD, WHICH RESULTS IN THE SERIOUS BRUISING OF THE FRUIT.

FIG. 2.—FLORIDA FIELD CRATE WITHOUT A CENTRAL PARTITION AND ONE TYPE OF SMALL PICKING RECEPTACLE OPENING AT THE BOTTOM TO AVOID BRUISING THE FRUIT BY DROPPING.

PICKING RECEPTACLES AND FIELD BOXES FOR FLORIDA CITRUS FRUITS.

FIG. 1.—GROCERS' DELIVERY CRATES USED BY SOME GROWERS FOR HOLDING ORANGES.

This crate supplies maximum ventilation and has no sharp corners or projections to injure the fruit.

FIG. 2.—BROKEN FIELD CRATES.

The splinters, sharp edges, and projecting nails are common sources of serious injury to Florida citrus fruits.

TYPES OF FIELD BOXES FOR CITRUS FRUITS IN FLORIDA.

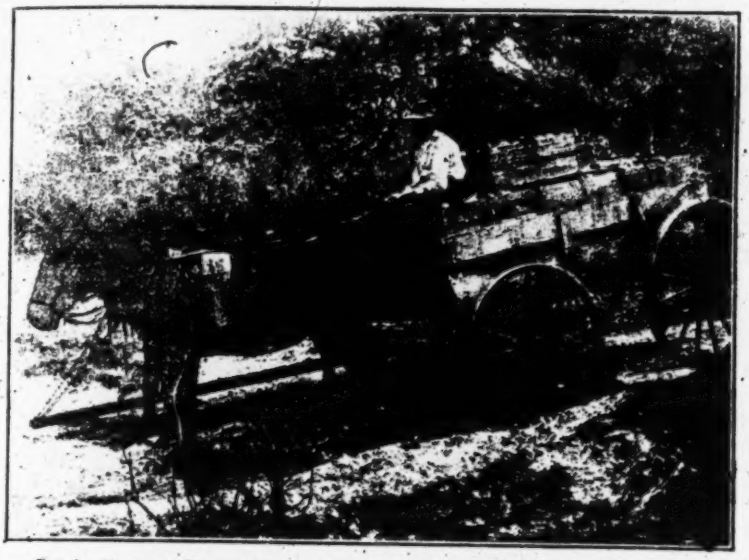


FIG. 1.—HAULING ORANGES OVER ROUGH ROADS ON WAGONS WITHOUT SPRINGS.
The jolting and jarring and the driver seated directly upon the fruit result in serious injury.

FIG. 2.—HAULING ORANGES BY TEAMS OF OXEN HITCHED TO SPRINGLESS WAGONS.

TRANSPORTING FRUIT FROM THE GROVE TO THE PACKING HOUSE IN FLORIDA.

FIG. 1.—GRAPEFRUIT CARRIED LOOSE IN THE BED OF A SPRINGLESS WAGON AND PILED IN THE GROVE.

Note that the wagon driver is in the act of throwing fruit from the wagon to the pile.

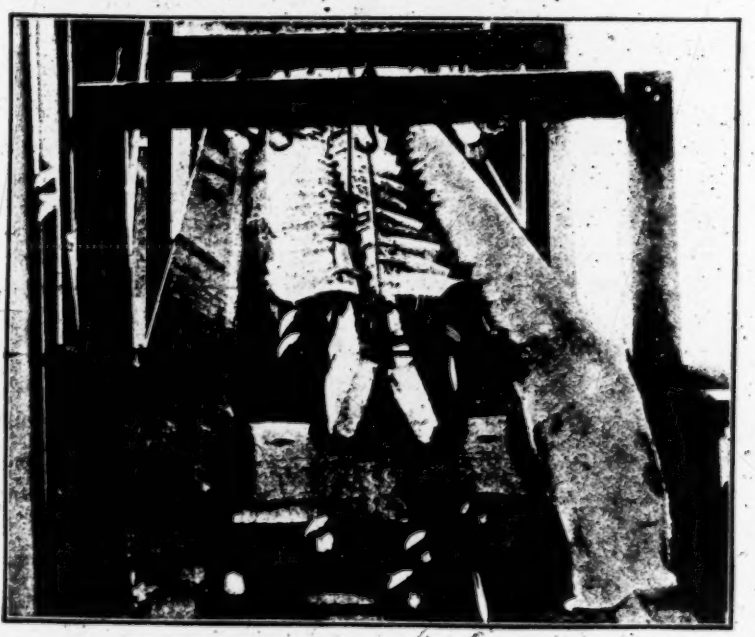


FIG. 2.—ONE TYPE OF ORANGE WASHER NOW IN USE IN FLORIDA.

careless methods. Along with the numerous improvements which have been effected during the past two or three years in the manner of hauling fruit from the grove to the packing house, must be reckoned the State-wide movement for better roads.

Preparing the Fruit for Shipment.

Buildings and machinery.—Packing houses are usually located in villages and towns along the railroad lines or in places accessible to water transportation. Many boxes of fruit, however, are packed either openly in the groves or in houses located near the farm buildings and are then hauled to a shipping point. Little attempt was made until recently to build houses especially designed for packing citrus fruit. The average building usually had a capacity for handling not more than one car a day, very little machinery being used in the old houses and the boxes being made by hand, frequently in some place outside the packing house. This building generally consisted of but one room, the sizing machine being located in the center, a little below the main portion of the house, in what is called the "pit." One common source of trouble, even in the new-style houses, is the attempt to save floor space. The machinery may be so adjusted that the orange has to follow a long and complicated path, around abrupt angles, down gravity runs, and up unnecessary elevators, whereas in a majority of cases the same end could have been attained at less expense by means of a more simple arrangement. Simplicity should be the watchword in the adjustment of all packing-house equipment. Some houses have gone to the other extreme of doing practically all the work by hand, thus eliminating the expense of carrying belts and other automatic devices. The character of the workmen is then of fundamental importance, and it is doubtful whether in the long run, hand work can be accomplished with as little injury as results from the use of properly adjusted, simple machinery.

(Here follow pages 405, 406, 407, and 408)

Fruit which was clean and did not require washing was formerly poured into a hopper and rolled by gravity in front of the grader to the sizing machine. The latter was some-

times run by power, but more often it was treadled by the man who did the grading. As the oranges were sized they fell into different bins and from these were packed out [fol. 409] (Pl. V, figs. 1 and 2). In most of the houses at the present time the fruit is carried in front of the graders on canvas belts to the sizing machines, which are usually run by power. The majority of the packers now wish to ship their fruit as soon after picking as possible. Some, however, still keep it for a couple of days to wilt or "cure," as the process is called.

Cleaning.—During the past few years cleaning the fruit has become more and more necessary because of the spread of the white fly. At the present time probably 75 per cent of the Florida orange crop is cleaned either by washing or by the sawdust method. Until some method of controlling the white fly has been discovered, it will be necessary to continue these processes and even to extend them to a larger proportion of the fruit.

Various methods of washing are used, and many different types of washers are now in operation in the State. Some of the machines developed and used extensively in California have been installed, and other types have originated in Florida. The fruit is either dumped into a small hopper leading to a tank of water or is emptied directly into the water, and the cleaning process consists of passing the fruit, either while in the water or while still wet, over or between rapidly moving brushes, which remove the sooty coating from the skin (Pl. IV, fig. 2, and Pl. VI, fig. 1). A number of washers are used in which the cleansing is done by means of sponges or rags. After the fruit has been washed it is run through "artificial" forced-air blast driers or else elevated to drying racks (Pl. VI, fig. 2) and when dried is ready to be graded and sized.

Another method of cleaning citrus fruits, especially grapefruit, is with sawdust. Large horizontal cylinders are completely filled with fruit, a few pounds of wet sawdust are added, and the cylinders are then revolved for 8 or 10 minutes by hand or other power. The movement of the sawdust over the surface of the fruit rubs off much of the dirt and sooty mold. No drying is required after this process (Pl. VII, fig. 1).

Grading.—There — set rules for grading oranges and grape-fruit in Florida. As a rule, only two classes are made, "brights" and "russets," in addition to a poorer grade which is shipped to near-by markets. The bright fruit is that which is free from the effects of the work of the rust mite, a small mite which punctures the oil cells in the skin of the fruit, causing the surface to become brownish in appearance. The russet grade is composed of fruit more or less affected by the work of the rust mite. Fruit affected with melanose, a disease common in many sections, is also usually placed in the russet grade. The russeting due to the work of the rust mites is quite characteristic of the Florida orange and has been almost a trade-mark for the fruit, the general impression prevailing in the North that such oranges are a distinct variety grown only in Florida. Consequently, this grade frequently brings as much money as bright fruit. It has never been determined that the work of the rust mites affects the quality of an orange or grapefruit. The number of mites varies considerably in different localities and even in groves in the same locality, and when present they may be largely controlled by the use of sulphur sprays or by dry sulphur blown upon the trees.

A few packing houses in the State make more than two grades. The finest of the bright fruit may be packed as "fancy," or some of the brightest russets may be labeled "golden." There are no uniform rules in the State, however, and similar grades of fruit from different packing houses may be sold under different names. Moreover, all grading is without reference to the size of the fruit. As one man grades a car or more of fruit each day, the work can not be done very thoroughly. There is a strong tendency at present to establish more definite grades and to secure better methods of grading (Pl. VII, fig. 2).

The sizes of Florida oranges vary from 80 to 420 fruits in a box, some fruit occasionally falling outside even these wide limits. The common sizes are 126, 150, 176, and 200 [fol. 410] oranges to a box. When only two grades of fruit are made, a double sizing machine is commonly used, and both grades are sized at the same time (Pl. VIII, figs. 1 and 2).

The Florida grapefruits are packed with 28, 36, 46, 54, 64, 72, 80, or 96 fruits to the box, the most desirable sizes

being 46, 54, and 64. The "Standards" vary from 54 to 80. Fruits packed 46 to the box and larger are known as "large off sizes," grapefruit being occasionally offered as large as 18 to the pack. This is more of a novelty than a commercial proposition, however. The "small off sizes" are those packed 96 to the box and smaller. Some of the regular orange-sizing machines can be adjusted for the sizing of grapefruit, but few of them are wholly satisfactory, on account of the variation in shape of the fruit.

Packing.—Many houses now employ girls and women as packers, although formerly the work was done almost exclusively by men, who were usually paid by the day. High-grade work is done on the average, and considerable care is taken to have each orange put in its place with a little pressure. This makes a firm pack and one which is smooth and of good appearance. The box is filled an inch or more above the top, and when the cover is put on pressure is used to bring the fruit at the ends even with the top of the box. A few shippers fill their boxes much higher than this, thereby making necessary considerable pressure in order to nail on the cover. This type of package, known as the "bulge pack," was developed to meet the buyers' demands for a full box of fruit on arrival in market. High packing is often an excuse for poor packing, however, since oranges which are laid in the box loosely and without pressure must be forced into place when the cover is nailed on, thereby increasing the liability of crushing the fruit in the top layers. A pack which is of medium height, with every orange firmly in place, is less liable to be injured in transit than is a high, loose pack, and the fruit will arrive in market with a more attractive appearance and will remain in good condition for a longer period.

The "nailer" takes the box after it is packed, and holding the cover across the fruit with both hands, he gives the box two or three sharp jolts upon the floor, first at one end, then at the other, before nailing it fast. Box presses are in use in a number of houses in the State. Whether the nailing is done by hand or with the aid of a press, care should be exercised to avoid injuring the contents of the top layer against the sides and ends of the box. Some pressmen have the habit of adjusting the covers after pressure has been applied by tapping the ends of the slats,

FIG. 1.—EXTREME TYPE OF LARGE HOPPER FORMERLY IN USE, THE SIZE BEING INDICATED BY THE SIZE OF THE MOWING MACHINE AT THE RIGHT.

The fruit is emptied from outside through trap doors in the background, a wagonload at a time. Serious injury is caused by bruising and by the twigs and other debris accumulating on the floor of the hopper.

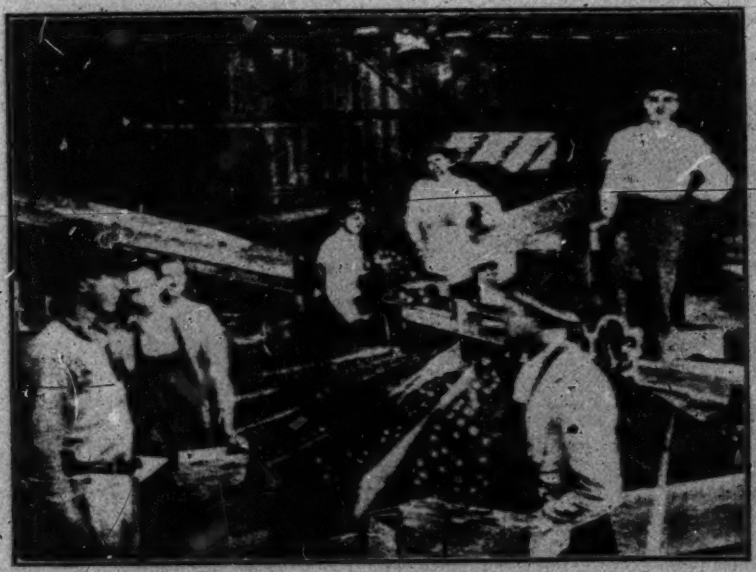
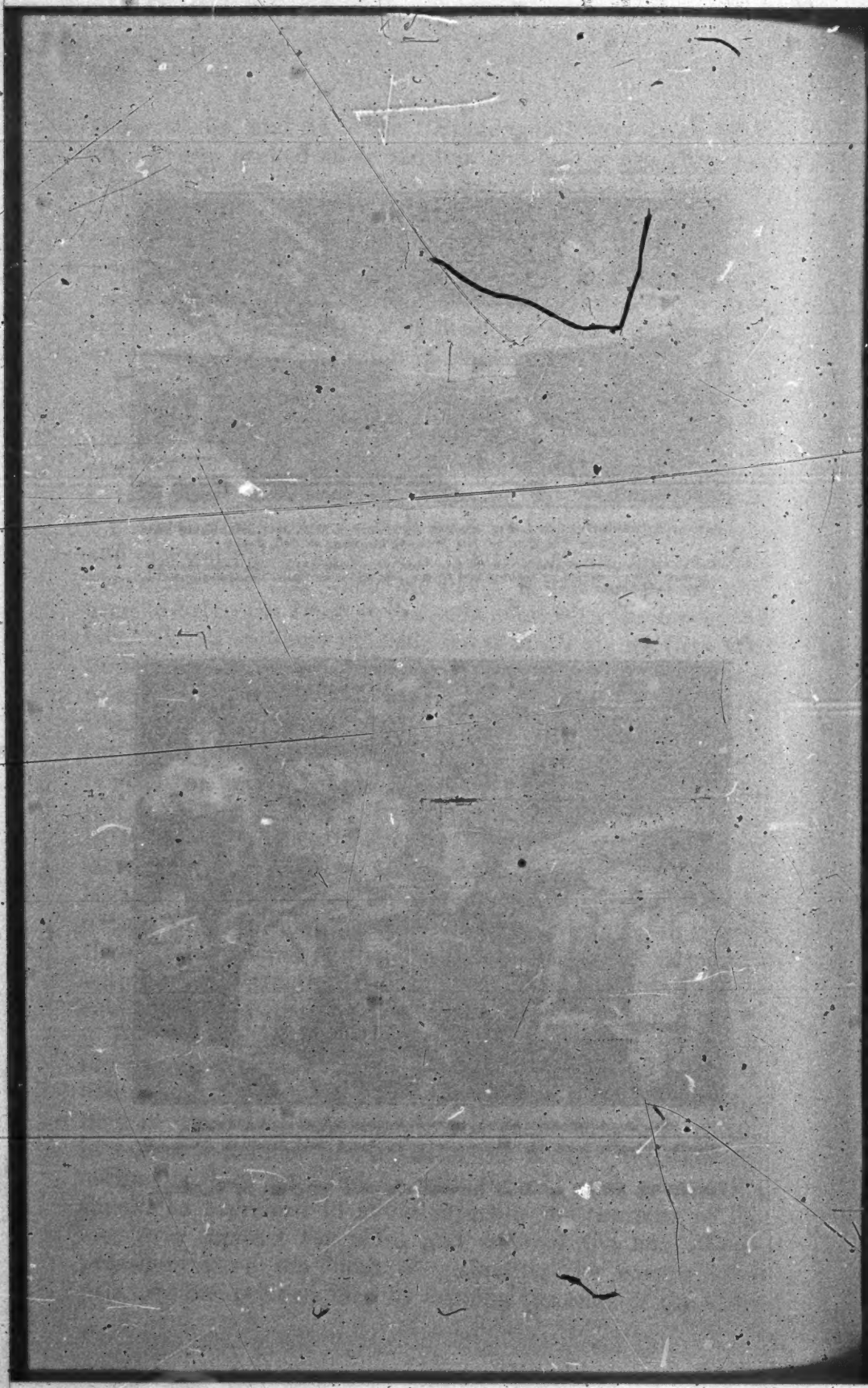


FIG. 2.—ANTIQUATED MACHINERY FOR GRADING AND SIZING THE FRUIT.

Note that the sizing machine is being treadled by the grader. Note also the lar e hopper at the rear.

INTERIOR VIEWS OF OLD ORANGE-PACKING HOUSES IN FLORIDA.



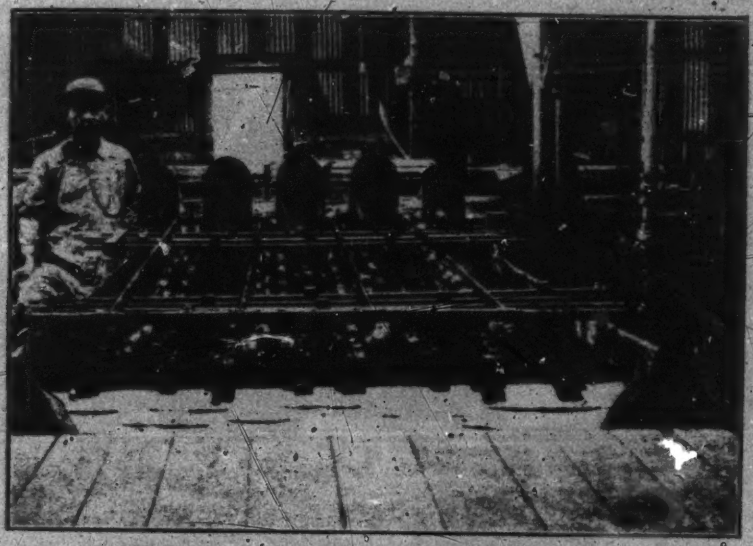
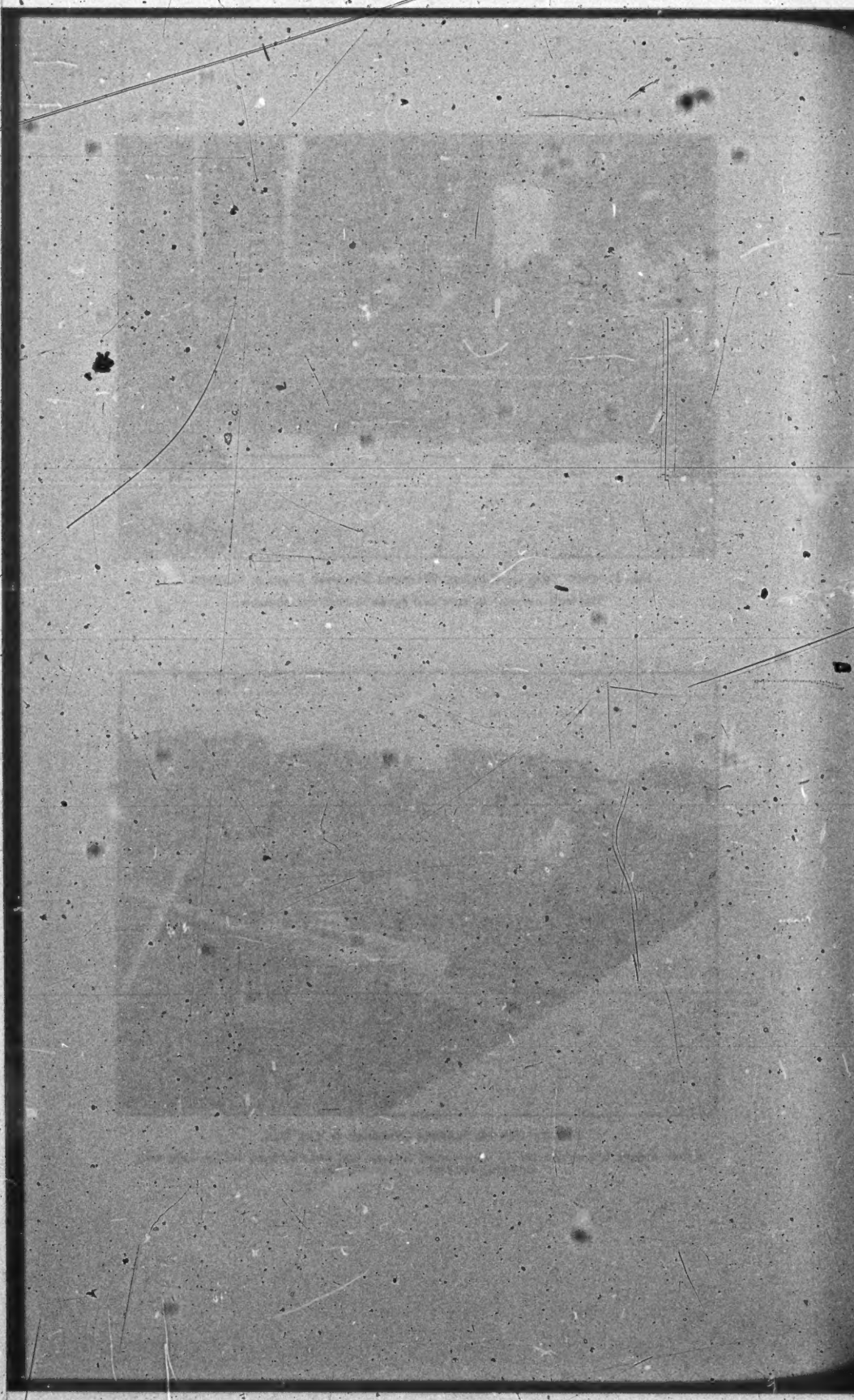


FIG. 1.—ONE TYPE OF ORANGE-WASHING MACHINE USED IN FLORIDA.
The fruit is always in sight as it passes through the machine.

FIG. 2.—DRYING FLORIDA ORANGES IN THE SUN.
Serious injury follows the use of unprotected brooms, and bruising from rolling over and dropping through steep gravity runs.



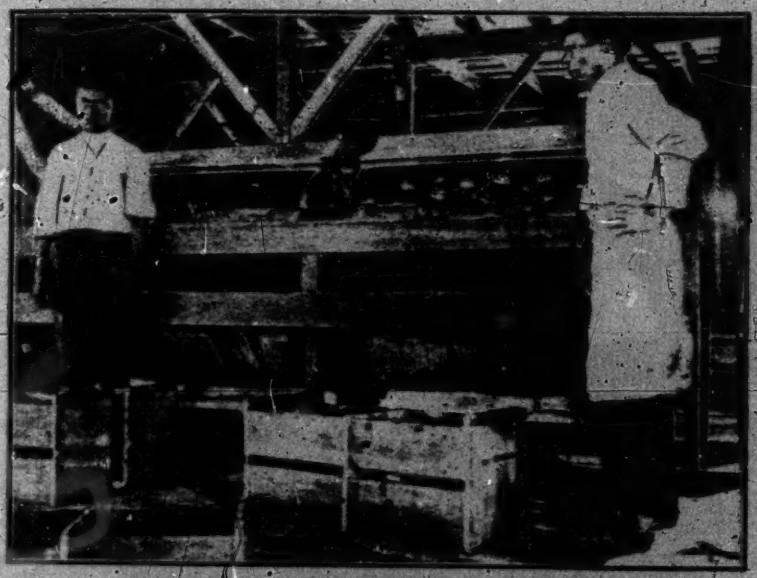


FIG. 1.—A SAWDUST CLEANER FILLED WITH GRAPEFRUIT.

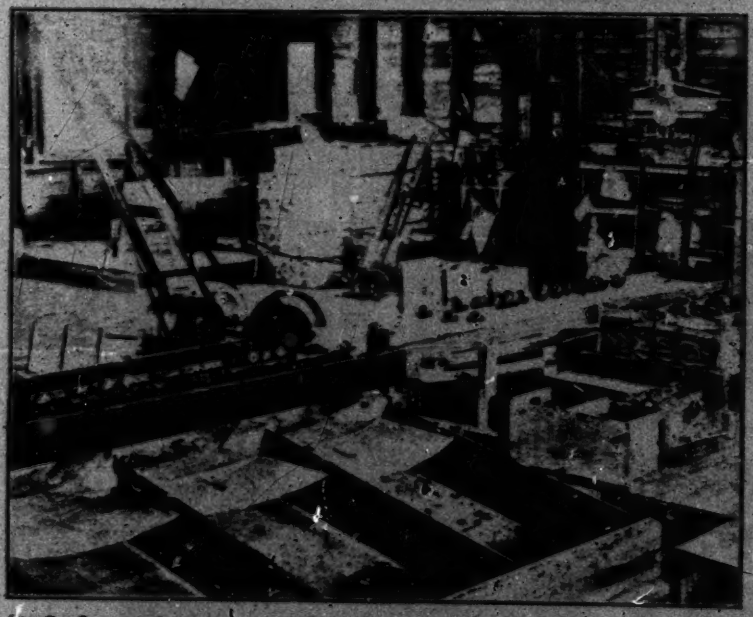


FIG. 2.—GRADING BELT BUILT BY THE BUREAU WORKERS FOR EXPERIMENTAL PURPOSES TO REPLACE THE LARGE HOPPER SHOWN IN PLATE V, FIGURE 1.

PACKING-HOUSE MACHINERY IN FLORIDA.

FIG. 1.—TYPE OF ORANGE SIZER, HOPPER, AND BINS USED IN THE OLD PACKING HOUSES IN FLORIDA.

FIG. 2.—ONE TYPE OF SIZING MACHINE IN A MODERN PACKING HOUSE IN FLORIDA.

ORANGE-SIZING MACHINES.

but this scratches or rasps the fruit on top and serious injury sometimes results. The beveled ends, sides, and center pieces which are coming into general use are of great value in preventing injuries during the nailing operation.

The Florida shipping box for both oranges and grapefruit measures 12 by 12 by 27 inches, inside dimensions, and has an estimated weight of 80 pounds when filled. It is made with paneled heads, has sides of veneer in one piece, and is bound with three straps of birch or other wood. Wire hoops are now used extensively in place of the wooden straps. This makes a strong package, suitable for long-distance shipments.

Shipping.—More attention than formerly is now being given to loading the fruit in the cars. It has been the custom to stack the boxes loosely in the cars, those in the lower tier standing on end and the rest placed lengthwise on top. On account of the strength of the box and the comparatively short haul, the loading is done rather carelessly, very little bracing being used, and often none at all. Although it is not common for the boxes to reach the market in a broken condition, considerable injury in transit is liable with a load of this kind. The better method now coming into general use in Florida is to stack the boxes two tiers high on end, using a car strip across each row and bracing the load securely in the middle. This insures a minimum of broken boxes or other injury on arrival in market.

(Here follow pages 411, 412, 413, and 414)

[fol. 415] The length of time in transit from central Florida to Philadelphia or New York varies from four days to more than a week. There are several routes by which fruit may be shipped to northern points. It may go "all rail" by freight, either in carloads or by local freight. Small consignments are sent by express to Savannah and from there by freight to their various destinations, and some fruit is shipped by water from both Jacksonville and Savannah. The rates to northern points vary somewhat by these different routes. Jacksonville is the basing point, and the "all rail" freight rate thence to Baltimore is 43 cents per box in carload lots. This rate to New York is 46 cents, to Boston 51 cents, to Pittsburgh 52 cents, and to

Chicago 53 cents. The water rate from Jacksonville is 35 cents to New York and 40 cents to Boston. In less than carload lots the "all rail" freight rate to Baltimore is 47½ cents, to Boston 59 cents, and to Chicago 97.2 cents. These rates apply on shipments moving through Jacksonville for points beyond. The rate is higher when the fruit is shipped to Jacksonville, the freight charges paid there, and the shipments rebillled to points beyond. In addition to the above charges the shipper has to pay the local freight from his shipping station to Jacksonville. This local freight rate per box is 15 cents from Orlando, 20 cents from Arcadia, and 26 cents from Miami.

During 1912-13 there were 321 boxes in the average carload. A few men shipped 400 or more boxes per car, but this practice should be discouraged. Such heavy loading leaves no space in which the air may circulate and affords a splended opportunity for the development of decay in transit. The Florida car is smaller than the one used by the California shippers and should contain not more than 360 boxes. The inside measurements of the standard shipping car for oranges are 33 feet in length, 8 feet in width, and 84½ inches in height. The minimum freight weight of a standard car of 300 boxes is therefore 24,000 pounds, reckoning each box at the arbitrary weight of 80 pounds. The freight rate is assessed per box, the average rate on citrus fruits shipped from Florida during 1912-13 being 65.7 cents per box of 80 pounds' weight. A car of oranges may contain boxes of oranges of all sizes, the fruit being generally loaded in the cars "orchard run," although some purchasers specify in advance the sizes desired.

Refrigeration and ventilation.—Prior to the season of 1912-13, nearly all of the shipments of Florida citrus fruits were handled under ventilation. A few of the late oranges, especially Valencias, have been shipped under refrigeration during the latter part of the season when the weather was warm either in Florida or while the fruit was in transit, but it is estimated that not more than 1 per cent of the shipments of citrus fruits were iced in any season previous to 1912. The condition surrounding the citrus-fruit industry of Florida have been largely responsible for the lack of the proper facilities for the shipment of oranges under ice. Before the reorganization of the industry, following the

introduction of modern handling and packing facilities, there was little or no opportunity to utilize refrigeration in transporting the citrus crop to market. A large proportion of the fruit was handled in local consignments to central points, such as Jacksonville, Fla., or Savannah, Ga., and at these gateway cities carload shipments were made up. In some instances the fruit was sent by boat to Jacksonville or Savannah and thence forwarded north by railroad. During the past three or four years this practice has changed to a very great extent, and at the present time only a small proportion (if any) of the shipments of Florida citrus fruits are assembled after local shipment at the central points mentioned. Packing houses equipped with modern appliances have been erected throughout the State. Full carloads are now made up at these houses and the fruit is shipped north direct from the point of production or packing. The opportunities for utilizing refrigeration have thus been increased, as the fruit can now be loaded direct into iced cars instead of being first shipped locally in unprotected "ventilator" or box cars.

The prevailing opinion among fruit growers and shippers formerly has been that Florida citrus fruits do not need refrigeration. Practically the entire crop is moved during the [fol. 416] winter and early spring months, when the prevailing outdoor temperature is low, so low at times that the problem has been to protect the fruit from freezing rather than to reduce its temperature by artificial means. During periods of extremely cold weather refrigeration may be a distinct disadvantage rather than otherwise. With the present refrigerator-car equipment, the insulation provided to keep the fruit cool during transit must also be relied upon to protect the fruit from freezing. This it does by retarding the cooling of the fruit and reducing its temperature very slowly, thus enabling the car to reach the market before the contents are actually frozen. It is easy to see that the length of time required to cool the fruit to an injurious extent depends upon (1) the outdoor temperature, (2) the efficiency of the insulation of the car, and (3) the temperature of the fruit at the time the car encounters extreme weather conditions in the North.

The present-day refrigerator car is only partially efficient during extreme weather. There are many types of

refrigerator cars with varying insulation, but none are able to withstand extreme cold for any considerable length of time without the use of artificial heat, just as they are unable to keep the contents cool in hot weather without the use of ice. It follows, then, that under ordinary conditions during cold weather fruit which has been cooled by the use of ice during the early part of the trip from Florida will be more liable to injury from freezing than fruit which has not been so cooled before it is subjected to extremely cold weather. The appreciation of this point is of great importance in discussing the refrigeration of Florida oranges, because a very large proportion of the crop is moved during periods of excessively cold weather in the North, although the temperature in Florida may be sufficiently high to warrant the use of ice at the beginning of the trip.

The investigations of the Bureau of Plant Industry have amply demonstrated that Florida oranges may be transported to market under ventilation with a minimum loss from decay, even during periods of warm and humid weather, if sufficient care is used to preserve the skin of the fruit in a sound, unbroken condition. None of the experimental shipments commented upon in this paper were refrigerated. The use of refrigeration during transit to market must not be considered as a means to offset the effects of rough or careless methods of handling. Icing can not permanently prevent deterioration. The low temperature only temporarily arrests the development of the decay fungi. As soon as the fruit has been unloaded in market it warms up, and decay develops very rapidly if a considerable number of the oranges have been injured by careless handling. As a result such fruit soon gains a reputation for very poor market-holding qualities. It is as important to have the fruit reach the consumer in good condition as it is to have it arrive in the market sound.

A considerable number of shipments were iced during the season of 1912-13, especially during January and during a later period of warm, humid weather, when heavy decay developed in nearly all shipments. It is safe to say that the number of cars handled under refrigeration during this season was greater than during all previous seasons together. Many of the shippers claim that they have been able to place the fruit on the market in much better

condition when shipped under refrigeration than when shipped under ventilation only. This conclusion is based upon a comparison of iced and noniced shipments. It is probable, however, that the comparison was not always fair, for the reason that no systematic study was made of the behavior of fruit of the same grade and quality under the two systems of shipment. Nevertheless, the general opinion prevails among growers and shippers that icing has resulted in material benefit to the fruit and has yielded increased returns. Refrigeration, therefore, bids fair to become an important factor in the handling and shipment of the Florida citrus crop.

During the past season, with its periods of excessively high decay, the Florida Citrus Exchange strongly urged its members to move their fruit north under refrigeration. The recommendations of the exchange officials, in brief, [fol. 417] provided (1) that the ice should be put in the tanks 24 hours before loading the fruit, and preferably 48 hours previous, in order to properly cool the cars; (2) that the boxes of oranges should be stacked near to the car and when the doors were opened the loading should commence immediately and not consume more than one hour; (3) that the doors should then be tightly closed and the car moved forward immediately. Since the refrigerating rates are per car and not per box, some growers loaded the cars very heavily this past season, shipping 400 or 500 boxes per car, in order to reduce the refrigerating charge per box. This left no room for ventilation or circulation of air, and as a result decay was heavy, especially in the top tiers. Boxes should not be loaded more than 2 tiers high and no car should contain more than 360 boxes. These may be loaded 6 rows across, 30 boxes long and 2 tiers high, on end.

Many refrigerator cars were shipped under one-half icing during 1912-13. When the fruit was very soft or from groves known to be diseased, full icing was found to be necessary. Table I gives the refrigerating rates for half icing from Florida to various points throughout the United States, these being in addition to the regular rates for transportation. When the entire ice bunker is filled, the charges are increased 50 per cent above those for half-bunker icing. For example, when the half-bunker rate to New York is $50 per car, the full-bunker rate is $75.

Table I.—Rates per Car for Half Icing from Florida to Points in the United States, Season of 1912-13

To southern points In State of	Rate
Georgia	$35.00
Alabama	40.00
Tennessee (except to Chattanooga)	45.00
To Chattanooga	40.00
Kentucky	45.00
Mississippi	45.00
Texas	62.50
South Carolina	35.00
North Carolina	35.00
Virginia (as to Lynchburg, Norfolk, Richmond, Roanoke, and Portsmouth)	45.00

To eastern points From Jacksonville	Rate
Taking rate of—	
43 cents per box	$45.00
44 cents per box	45.00
46 cents per box	50.00
48 cents per box	45.00
50 cents per box	50.00
51 cents per box	55.00
52 cents per box	50.00
53 cents per box	55.00
55 cents per box or higher	55.00

To northern and western points In State of	Rate
Ohio	$50.00
Indiana	50.00
Michigan	55.00
Illinois	50.00
Wisconsin	55.00
Missouri	55.00
Nebraska	55.00
Kansas	55.00
Colorado	62.50
Minnesota	55.00
Iowa	55.00

Marketing the Fruit

Non-cooperative buyers.—Most of the Florida citrus fruits have been handled on the market by fruit buyers and speculators. Large quantities have been bought on the trees, either in bulk or at a fixed price per box, by local buyers who own packing houses in near-by towns. There are many such buyers, and, although very few of them are growers, they purchase enough fruit each year to pack and ship thousands of boxes. The largest part of the Florida citrus crop has been handled in this manner in recent years, the picking and hauling being done under the direction and at the expense of the buyers. These men have regular customers to whom they make shipments, and they also consign large quantities of fruit to commission houses. If a grower desires to pack his own fruit, he may be able to sell it before shipping it, but usually he consigns the cars to a commission man whose agent has solicited his trade. If the grower is doing business with a reliable firm, the success of this method depends largely upon having a good grade of fruit which is packed in an attractive manner and reaches the market in sound condition. Since most of the commission houses operating in Florida are located in the larger northern and eastern cities, the heavy shipments of fruit to these points often cause the market to be glutted with Florida oranges.

[fol. 418] Several large selling agencies are now operating in Florida and are handling much of the citrus fruit. These firms may or may not be directly concerned with the grading and packing of the fruit. Although in a few instances they control this portion of the work almost entirely, and so are able to offer for sale large quantities of fruit of a rather uniform grade, their primary aim is to handle for the packers all matters pertaining to the sale of the crop. They claim to be able to keep a closer watch on the markets and on general trade conditions than an individual grower or packer can possibly do, and, by means of competent sales agents throughout the country, to be able to control the distribution of the product so as to avoid gluts and the resultant low prices. Their selling charge may be a flat rate per box, but more often the business is conducted on a percentage basis.

Florida Citrus Exchange.—The movement for cooperative marketing, begun during the season of 1909-10, gained considerable headway among the citrus fruit growers of the State and resulted in the formation of the Florida Citrus Exchange. The organization was modeled after the California Fruit Growers' Exchange, which has been successfully packing and marketing a large percentage of the citrus fruits of California for a number of years. During its first season (1909-10) the Florida Citrus Exchange handled more than 1,000,000 boxes of fruit.

The Florida Citrus Exchange is composed of a number of cooperative associations throughout the State. These are made up of individual growers who form a corporation, build a packing house, elect a manager, determine the grades under which their fruit is to be shipped, and attended to all the business directly connected with the harvesting, packing, and shipping of the fruit. The cooperative packing houses located in any one of the several citrus districts of the State unite to form a subexchange, whose manager has charge of the larger business interests of the houses in his district, keeping in close touch with the central offices of the exchange, and advising with them regarding the qualities and grades of fruit in the various cars shipped, the methods of packing employed, and all other matters regarding which a selling agency should be well informed. A union of the various subexchanges forms the Florida Citrus Exchange, which has its headquarters at Tampa. This is an incorporated body, with a board of directors and officers for carrying on the business of marketing the product. Representatives of the exchange, who are paid on a salary basis, are located in the various trade centers and have charge of the sale of the fruit.

The fruit of the individual grower may be handled in the packing house as a separate account; or it may be packed under certain grades, a record being kept of the number of boxes of each grade made from the fruit of that grower, whose identity is lost as soon as this amount has been recorded. When the latter plan is followed, the season is generally divided into periods of several weeks in length, called pools, the receipts for all fruit shipped during each period being averaged by grades. The individual grower receives a pro rata share of the proceeds, determined by the quantity of each grade of fruit which he has delivered at the

packing house during that pool. In a few packing houses one pooling period extends over the whole season, and the only average made is based upon the proceeds of the entire crop.

Keeping Quality of Florida Oranges

The keeping quality of the orange is naturally good. Since the life processes of the fruit continue after it has been severed from the branch, there is a prolonged period during which an uninjured orange remains sound and free from all decay. Ultimately, when the life span has been run, the tissues die and decay follows even in uninjured fruits. The delay is long enough, however, to allow the average fruit to be packed and placed on the market and to reach the consumer in sound condition.

[fol. 419] Heavy Losses from Decay in Commercial Shipments

The losses from decay during transit have been very heavy in the commercial shipments of fruit, and the experimental work of the Bureau of Plant Industry was undertaken in Florida in response to the many requests for advice and assistance which came to the Department of Agriculture. It is difficult to estimate what the actual loss from this cause has been during past seasons. Several reliable commission men who handle large quantities of Florida oranges each year have stated that averaging the good with the bad years probably 10 per cent of the fruit decayed before reaching the consumer. Experimental shipments made under the direction of this bureau indicate that the loss may have been fully as heavy as this.

Since Florida's orange crop averages 4,000,000 or 5,000,000 boxes per year, the decay of 8 or 10 per cent of this fruit entails an annual financial loss of at least half a million dollars. Ten per cent of 4,000,000 boxes amounts to 400,000 boxes, on which the picking and packing charges have been paid, with approximately $50,000 spent for box material alone. The freight charges represent something like $200,000; and these amounts, together with the commission charges, the value of the fruit discarded, and the cost of repacking what is left, bring the total loss high enough to seriously endanger the welfare of the industry.

Reputation Injured by Decay in Transit

Unfortunately, the financial injury is not confined to the fruit actually decayed. It is impossible to estimate the loss which has resulted to the industry from the bad reputation which Florida fruits have gained in the trade. While it is difficult to discover how far the low prices occasionally received have been due to this cause, many fruit handlers in northern markets condemn very strongly the poor keeping quality of the Florida orange and willingly admit their intention of using fruit of better keeping quality if they can obtain such from other points. The situation of the Florida orange grower would be critical indeed if it were not for the fact that fruit handled carefully shows so much less decay than does fruit picked and packed under careless commercial conditions.

History of the Department Work in Florida

Investigations by the Department of Agriculture, having in view the discovery of the factors underlying the successful shipment of oranges from Florida to northern markets, began during the season of 1907. The works which was planned along lines similar to those followed in the California investigations, included the determination of the character and type of handling employed in the various operations of preparing fruit for shipment and the discovery of the relationship between present methods and the occurrence of decay. The object of the work of the department was to suggest changes in the industry which should reduce the immense annual financial losses of the Florida growers by enabling them to market their fruit in sound condition.

The first researches in Florida were conducted by Mr. L. S. Tenny, who devoted his attention to an inspection of the work done by various picking crews and individual pickers, as well as to the character of work being done in the packing houses. It required only a short time to indicate that what had previously been found to be the case in California was also true in Florida, viz, that the fruit was receiving considerable injury in the course of its preparation for shipment. Conditions were, if anything, somewhat more exaggerated, owing to the fact that the thin-skinned, juicy Florida orange is of a more tender type and is more

easily injured than the bulk of the oranges grown in California. It is safe to say that the kind of handling which would enable the California orange to go through the various picking and packing operations without injury is not safe for the Florida product. The importance of avoiding dropping or puncturing by long stems is most urgent when [fol. 420] dealing with thin-skinned, juicy fruit. The necessity of handling with extreme care so perishable a product as the Florida orange can not be too strongly emphasized.

After the determination of the character of work being done and the discovery that considerable injury was being inflicted on Florida fruit, the investigations were so planned as to determine whether it was practicable to handle the fruit with sufficient care to prevent injury. At first demonstrations corresponding to those carried on in California were made in the packing houses, using fruit selected for soundness and similar lots showing injuries of various kinds. The effects of dropping the fruit and of washing it to remove sooty mold were also demonstrated. These lines of work proved conclusively that blue mold develops wherever the skin of the orange is injured in any way, and that dropping is followed by serious decay, especially when the fruit falls into a receptacle containing dry twigs, gravel, splinters, or other matter rough enough to bruise or puncture the skin.

After the packing-house demonstrations, showing that sound, uninjured Florida oranges are not affected with blue-mold decay, shipping experiments under commercial conditions were undertaken. These experiments consisted of forwarding boxes of fruit of known history to Washington, where the percentages of decay were carefully determined on the day of arrival and after one, two, and three weeks, the fruit meantime being held under ordinary open-market conditions.

These experiments were followed during five successive seasons, thus enabling the investigators to determine the effect of seasonal influences. The data obtained during 1910-11 and 1911-12, when the work was undertaken on a more extensive scale than in the former seasons, corroborated the early results without exception, and the carrying quality of the Florida orange when packed and shipped in sound condition was proved to be as good as that of the California product. An injured orange, whether grown in

California or in Florida, will decay whenever the conditions for the development of blue mold are favorable. A sound orange in good, healthy condition, whether grown in California or in Florida, is able to resist blue-mold decay.

Blue-mold Decay of the Orange

Indications of decay.—The characteristic appearance of the orange decayed by blue mold is too well known to need description. Every handler of citrus fruits knows blue mold, which is by far the most common form of decay. The grower frequently sees it in the oranges hanging upon the trees, when the fruit has split or has been injured by thorns or twigs. He finds it in the fruit which has dropped to the ground. The packer sees it in the cull pile or in the boxes of fruit left standing in the house for a few days. The receiver of the fruit finds the decay as the boxes are opened, and frequently he smells it before removing the covers.

The first indication of decay is a small area of soft tissue at some point on the surface of the fruit. This increases rapidly in extent if the weather is moist and warm, and within a day or two a bluish or greenish spot develops. If weather conditions continue favorable, the entire fruit is rotted within a few days, and the surface is generally coated with a bluish or greenish blue mat or powdery covering.

Blue-mold Fungus

Blue-mold decay is caused by the growth of a minute organism within the tissues of the fruit. Laboratory experiments have shown this organism to be a fungus of the genus Penicillium, which includes the familiar blue mold or mildew on bread, on the surface of canned fruit, and on other vegetable matter. Growth takes place within the orange, the bluish mat on the skin being composed of the fruiting bodies made up of chains of spores, massed together in great numbers. The fungus is spread by means of these spores, which, like the seeds of many higher plants, germinate and grow as soon as they find lodgment under conditions favorable for their development. They require heat and [fol. 421] moisture, and when these are present growth proceeds at a very rapid rate. The blue-mold fungus has not the power to penetrate the sound living tissue of a well-grown

fruit; hence, there must be a break or an abrasion of some kind in the skin, through which the disease may find an entrance. When growth has once started, even in a small way, the fungus is capable of killing the surrounding tissues and thus producing material on which to grow. This process continues until the entire fruit is destroyed. If, therefore, a fungous spore is present and lodges in an injured spot, the initial step toward decay has been taken, and if the temperature and moisture conditions during the next few days are favorable, the development of the fungus proceeds rapidly and the orange is almost sure to rot. Many experiments have been made in California and Florida packing houses in placing spores on fresh injuries, and, without exception, the characteristic decay has resulted. On the other hand, large quantities of fruit have been held under weather conditions most favorable to the development of decay, and the results prove that fruit which has been so carefully handled as to preserve the skin in an uninjured condition shows practically no decay even when the surface has been purposely covered with spores. The development of decay is most rapid during warm, moist weather, fruit packed during a cool, dry period frequently reaching the market without much waste even though injuries are present. Under changed atmospheric conditions, the same fruit may arrive in a badly decayed condition. During an average Florida winter there are usually periodical warm spells. Reports of general heavy decay at the market end can almost without exception be traced to fruit packed and shipped during these warm periods.

With this understanding of the nature and cause of the most common form of decay, it becomes easy to see how the harvesting and handling methods may have an important bearing on the keeping quality of the fruit. If these are such as to break the skin or injure the orange, even slightly, favorable conditions for the development of blue-mold decay exist and such decay is almost certain to result, as observation has shown that the spore of the blue mold are present practically everywhere. It is safe to say that most of the decay occurring in Florida oranges while in transit is due to blue mold. There is some loss in transit from decay due to other forms of rot, but this is usually very slight as compared with the loss from blue mold.

Causes of Blue-mold Decay

Since the principal means of securing oranges of good keeping quality is by eliminating mechanical injuries to the fruit, the occurrence of decay is therefore closely connected with the handling methods in use in the grove and packing house.

Thorn punctures, which are made while the fruit is still on the tree, are among the first injuries to which citrus fruits are subjected. These are generally unavoidable, as during every wind storm a certain percentage of the fruit is injured by being blown against thorns. The puncturing which occurs when the fruit is being picked may be prevented, however, although it is frequently difficult to handle the oranges with sufficient care to avoid pressure against thorns or dried twigs when these are present in large numbers. Fruit is often bruised when the ladder is placed carelessly in the tree or when the sack is allowed to strike or is pressed against the branches or ladder. (Pl. IX, figs. 1 and 2.) Moreover, filling the field boxes so high that the fruit projects above the top will result in crushing the oranges when the boxes are stacked one on top of another. The oranges may be bruised on their way from the grove to the packing house by being jolted over rough roads in springless wagons. The driver of each wagon should be given a specially prepared seat and not allowed to sit upon the fruit.

Among the most common forms of injury may be mentioned scratches made by the finger nails of the pickers and packers, each of whom should be required to wear gloves. It is comparatively easy for packers, especially if their finger nails are long, to seriously injure a large percentage [fol. 422] of the oranges which they handle. Some packers also do a great deal of harm by dragging the oranges around in the bins and by tossing the off sizes into the neighboring bins. Abrasions due to the presence of gravel, twigs, splinters, protruding nails, or other foreign matter in the picking receptacles, field boxes, or packing bins may have far-reaching consequences.

Bruises caused by dropping the fruit in the various stages of picking or packing have been found to cause serious loss from decay. There are a number of places where oranges may be greatly damaged by dropping. First of all, the picker may toss them carelessly into his picking basket or

bag. Careless pickers frequently throw the oranges into the open receptacle by means of a shove with the clippers, the fruit sometimes falling as far as 3 or 4 feet. Serious damage may also result from emptying the fruit roughly into the field box. Plate I, figure 1, shows how the bag or basket may be held too far above the box and the fruit allowed to fall too great a distance. In case the bottom of the box is covered with twigs or small pieces of dirt the injury is greater. A sack which opens only at the top and from which the fruit must be poured into the boxes is likely to cause severe damage because of the bumps to which the fruit is subjected. Usually no greater care is observed when emptying the fruit into the field box and from that into the hopper of the washer, grader, or sizing machine. The washing machine provides excellent opportunities for the infliction of mechanical injuries and for infection from dirty water. This phase of the subject will be discussed later.

Decayed fruit and trash should not be left in the boxes or allowed to accumulate on the floor and under the packing bins. The slightest breeze will scatter great quantities of blue-mold spores from these rotted oranges over all the fruit in the house. A clean, well-lighted packing house greatly diminishes decay by reducing the chances of infection. It has a beneficial influence on the workmen as well, offering a great incentive to better work. Moreover, a clean packing house is a good indication of the character of work being done throughout and indicates whether genuine efforts are being made to improve the methods of handling.

The hopper into which the fruit is emptied has always been the source of much injury to citrus fruits in Florida. In the old style of packing house, existing before the work of the Bureau of Plant Industry was begun, the hopper was frequently large enough to hold a wagonload of fruit. Few, if any, of these are now in use. Even the more desirable small hopper was constructed with such a steep gravity run that the fruit was subjected to a severe bump on reaching the bottom. In going through the machinery or over the grading table other chances for injury occurred, and the final drop into the packing bin was sure to add several bruises. The desirable hopper has padded sides and allows the fruit to be emptied gradually by means of moving belts, which carry the fruit to the washing machine or grading

belt; it is not necessary for the fruit to fall by gravity at any stage of its journey.

The most serious form of injury, however, is made by the clippers in removing the fruit from the tree. These clipper cuts are not as prevalent in Florida oranges as was found to be the case in the California fruit, for the reason that the Florida oranges are round and do not have the depression at the stem end which exists in the Washington Navel. Nevertheless, enormous damage has been done to the Florida fruits either by cutting the skin near the stem end when severing them from the branch or by puncturing them with the points. It is essential to have the ends of the clippers rounded or blunted in order to eliminate the possibility of piercing the fruit.

(Here follow pages 423, 424, 425, 426, 427, 428, 429, and 430.)

The presence of long stems on the oranges may be reckoned as equally disastrous. For this reason, in determining the character of work being done by a picking crew or individual picker long stems are included as imperfections. A long stem is just as serious, if not more dangerous, than an orange which has been injured in some way. The latter decays, but this rot seldom affects a neighboring orange; whereas a long stem has ample opportunity to injure a number of fruits in their progress from the tree to the [fol. 431] packing box. A sharp, ragged fragment of stem projecting from the orange will injure all the fruit with which it comes in contact in the picking bag, field box, brusher, washer, or packing bin. When it is considered that long stems are probably the most common imperfections found in the work of the Florida crews, the importance of giving particular attention to the picking becomes apparent. In most instances it is impossible to avoid leaving long stems, unless the so-called double cut is made. This means that the fruit is first severed from the tree with a stem half an inch long, which is trimmed off when the fruit is held in the hands of the picker. This enables the workman to cut closely and carefully without danger of clipper cutting, and at the same time it prevents him from throwing or "shooting" the fruit into the picking receptacle. Actual experience shows that it requires very little more time to make the double cut, and when the picker becomes accustomed to

FIG. 1.—LADDERS PLACED CARELESSLY IN THE TREE ARE VERY LIABLE TO CAUSE INJURY TO THE FRUIT.

FIG. 2.—WHEN THE FRUIT IN THE SACK IS PRESSED AGAINST THE LADDER THE EFFECT IS ALMOST CERTAIN TO BE INJURIOUS.

Bul. 69, U. S. Dept. of Agriculture.

PLATE IX.

PICKING ORANGES.

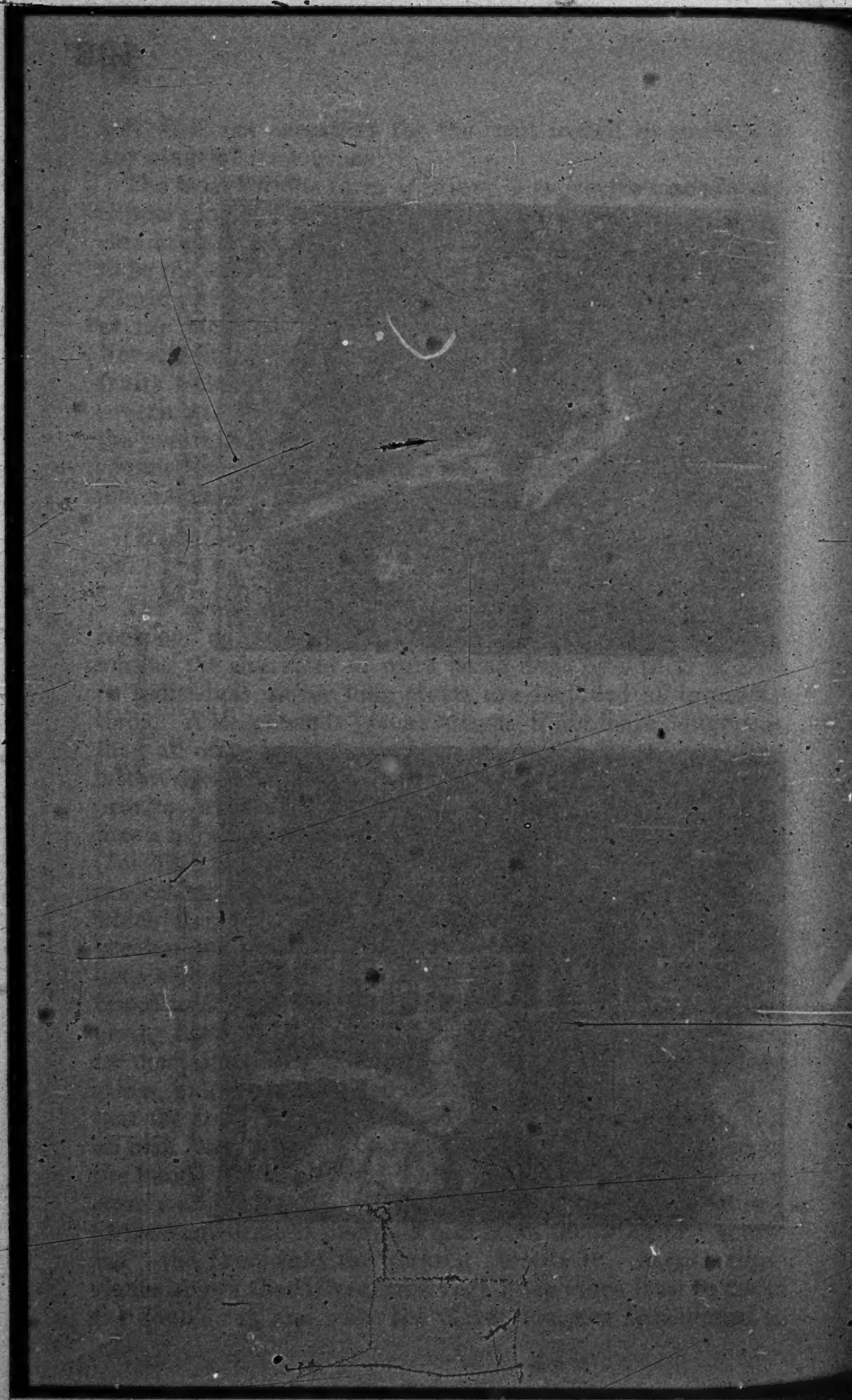


FIG. 1.—OLD PACKING HOUSE IN FLORIDA.

Showing a water tank made of an old wine cask and a pile of field boxes in the rear of which were hidden the spectators.

FIG. 2.—OLD PACKING HOUSE IN FLORIDA.

Showing the method of dipping the fruit into the hopper from outside.

TYPES OF OLD PACKING HOUSES IN FLORIDA.

FIG. 1.—A ONE-STORY COMMODIOUS BUILDING CONVENIENTLY ARRANGED FOR HANDLING CITRUS FRUITS.

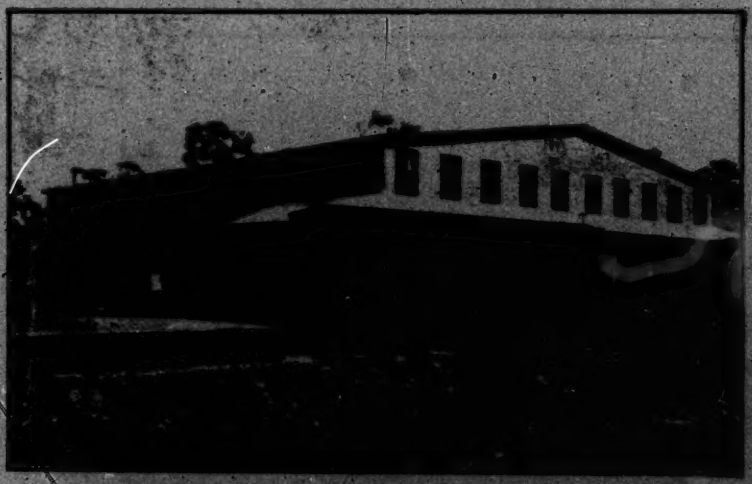


FIG. 2.—A TWO-STORY BUILDING WITH EXCELLENT FACILITIES FOR PACKING AND SHIPPING CITRUS FRUITS.

EXTERIOR VIEWS OF MODERN PACKING HOUSES IN FLORIDA.

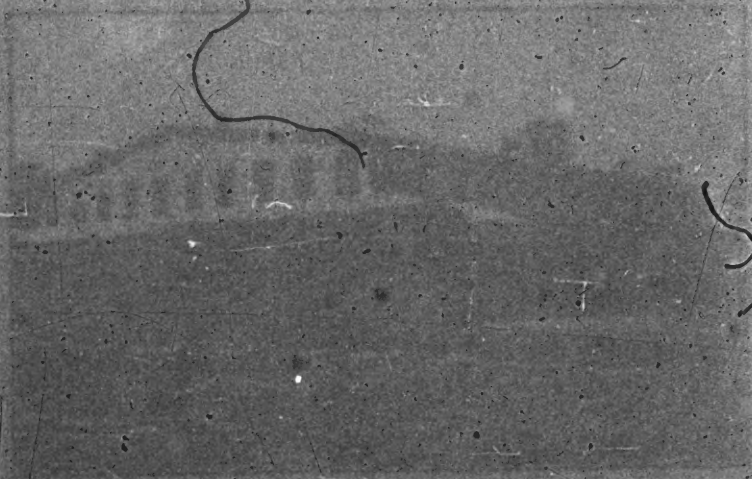


FIG. 1.—AN OLD BUILDING FORMERLY USED FOR PACKING CITRUS FRUITS.

Note the evidences of unsoundness, the boxes of grapefruit stacked outside, and the many broken field crates.

FIG. 2.—THE MODERN BUILDING WHICH HAS REPLACED THE ONE SHOWN IN FIGURE 1.

ANTIQUATED AND MODERN TYPES OF FRUIT-PACKING HOUSES IN FLORIDA.

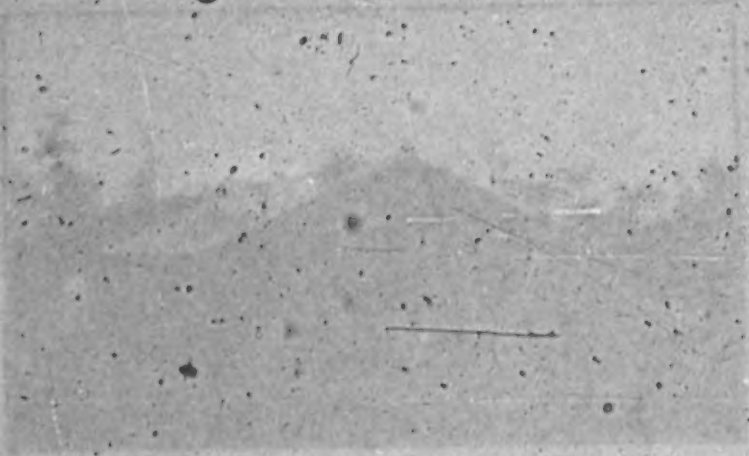


FIG. 1.—PACKING CITRUS FRUITS IN A POORLY LIGHTED AND OVERCROWDED ROOM.

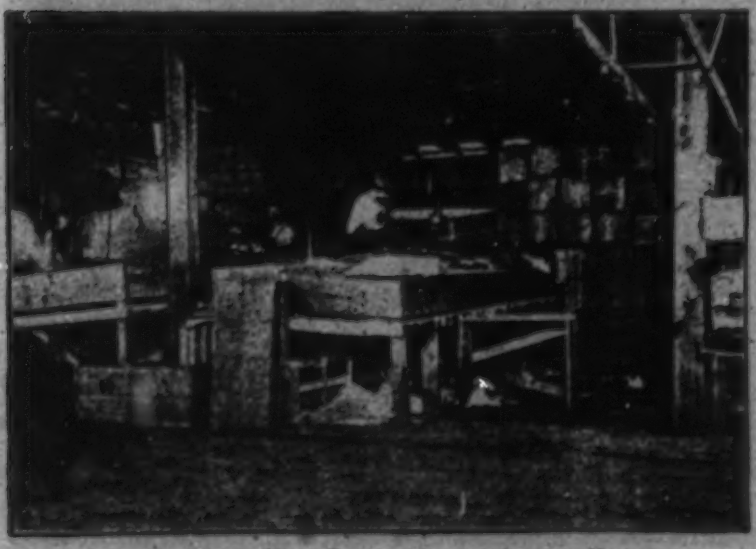


FIG. 2.—GRADING CITRUS FRUITS BY LANTERN LIGHT AT NIGHT.

INTERIOR VIEWS OF TWO OF THE OLD PACKING HOUSES IN FLORIDA.

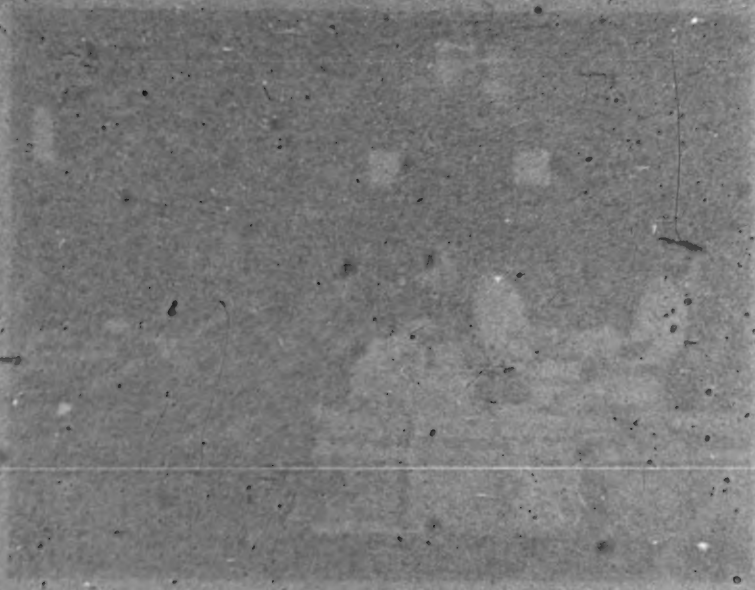


FIG. 1.—CORNER OF A WELL-LIGHTED BUILDING.

Showing the type of machinery used for grading citrus fruits. The interior of this building is shown in Plate XI, Figure 2.

FIG. 2.—GENERAL VIEW OF A CLEAN, WELL-ARRANGED BUILDING.

Showing new equipment for handling citrus fruits.

INTERIORS OF MODERN PACKING HOUSES IN FLORIDA

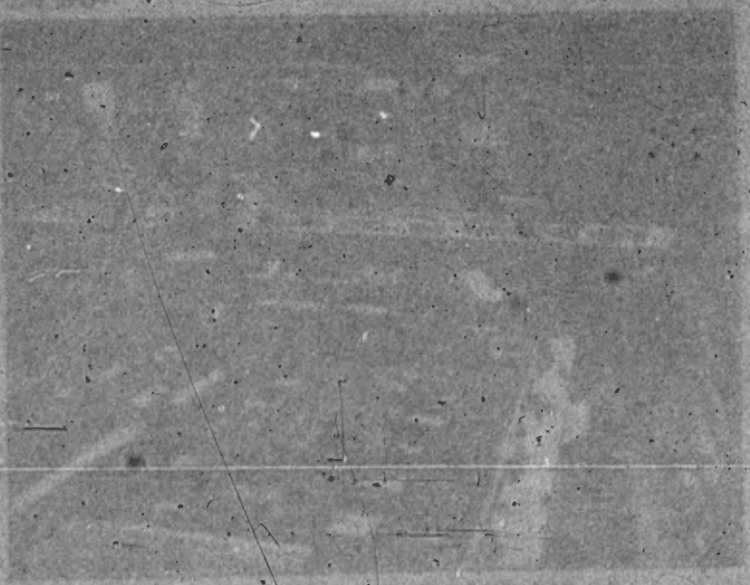
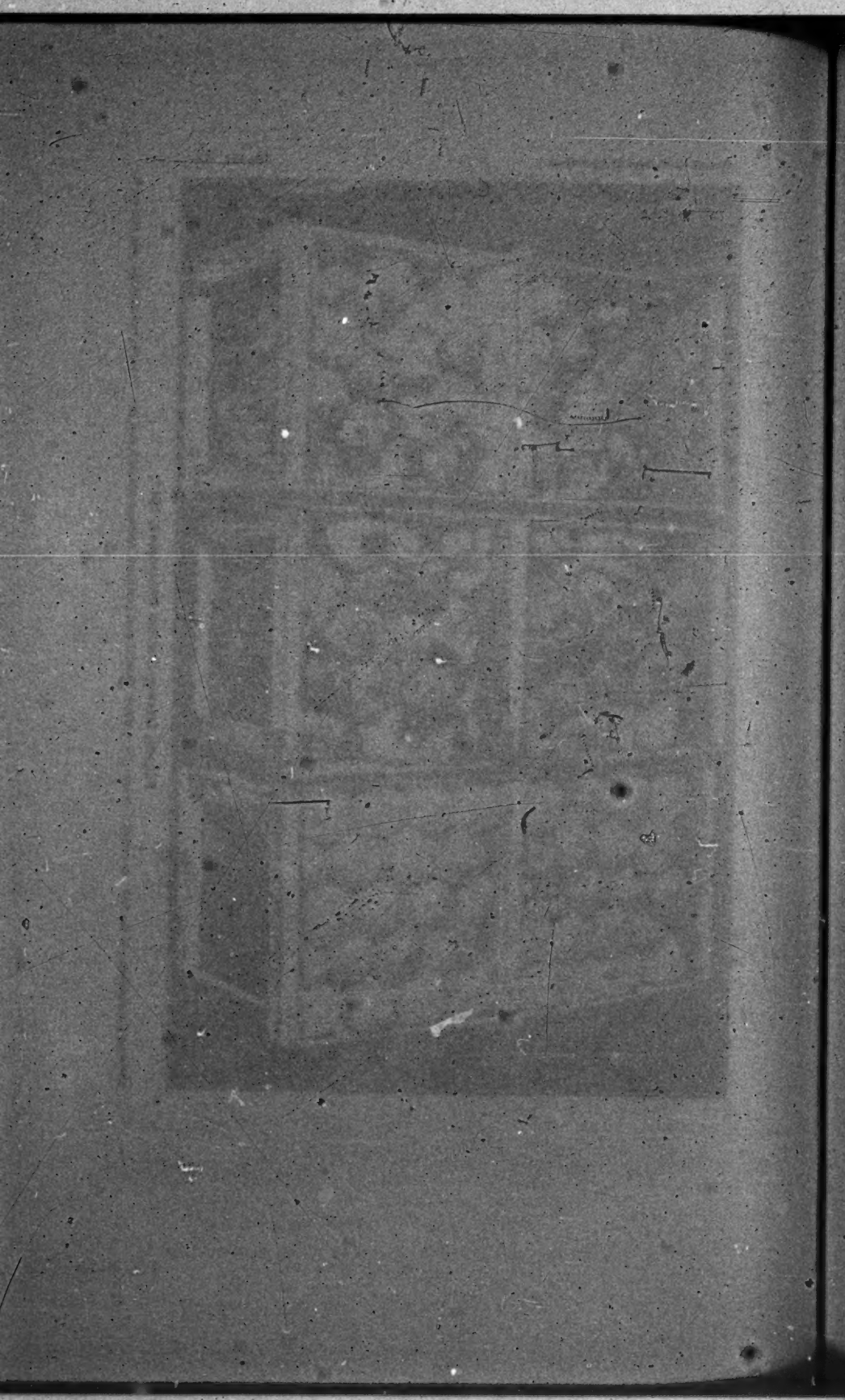


PLATE XV.

FLORIDA ORANGE-SHIPPING EXPERIMENT, 1911.

Showing the condition of the fruit on arrival. From left to right: Careful pick and pack, commercial pick and careful pack, commercial pick and pack.



clipping in this way he can operate practically as fast as with the old method, where he has to use care to prevent clipper cutting. Of course, it takes longer to make a careful double cut than to pay no attention to the character of the work performed. Since the picker is frequently unable to see the stem when the orange is on the tree, he consumes much time in adjusting his clippers in the right position. In making the double cut he is not concerned with the placing of his clippers, simply reaching out and severing the orange with a stem long enough to avoid contact between the fruit and the clippers; then when he holds it in plain sight he can easily make a smooth, close cut.

Evolution of the Florida Citrus Industry

The results of the bureau investigations emphasize the importance of having the fruit arrive in market in good condition and of having it remain sound while in the hands of the wholesale and retail dealers. Shippers are frequently of the opinion that their interest in the condition of the fruit does not extend beyond the percentage of decay found on arrival. It is realized that buyers can claim allowance for such decay, and consequently shippers are usually anxious to prevent it. In their opinion any decay which results after the fruit is purchased is the buyer's loss. This impression is erroneous, for the decay which develops after the fruit is in market is just as direct a loss to the growers and shippers as that which appears during transit. Although the shipper does not have to make a cash allowance for decay occurring during the market-holding period, brands which fail to remain in good condition lose their reputation and ordinarily do not command as high prices as do those which are known for their good market-holding quality. The wholesale and retail merchants want oranges upon which they can depend to remain in sound condition. For such fruit they are willing to pay a premium, while fruit which develops a high percentage of decay before it can be sold has nothing but its cheapness to recommend it. A grower or shipper who consigns carelessly or poorly packed fruit with the expectation that it will remain sound until it gets into market deceives no one but himself. He may be able to dispose of a few cars at fair prices, but the buyers soon learn

what to expect and prices fall accordingly. Fruit which develops a high percentage of decay while in the market is the poorest kind of an advertisement, not only for the brand under which it is packed, but also for the section of the State from which it is shipped.

In many cases growers and packers are anxious to do careful work, but they do not realize how many factors there are in the handling operations which may cause injury and therefore decay. They do not appreciate what careful handling means, and they underestimate its importance until the results are demonstrated to them. Injuries causing decay in citrus fruits while in transit and in market may occur from operations through which the fruit is put from the time it is taken from the tree until it is placed in the packing box. [fol. 432] It is the prevention of these injuries in grove and packing house that makes up careful handling, and both grower and packer are concerned in knowing how they are caused and how they may be eliminated.

At the time the department investigations were started the methods of handling Florida citrus fruits for shipment were extremely crude. Growers did their own picking, there was no uniformity of system, and the work was performed only indifferently well. These statements are not meant to reflect in any way upon the standing of the industry or to criticize the individuals who were concerned with the preparation of the fruit for market. Practically all of the imperfections were due to a lack of knowledge on the part of the growers and shippers and not to their desire to slight any of the important work. No one realized the effects of injury to the fruit, and few, if any, believed that injury was being inflicted. Growers and packers frequently greeted the department workers with the statement that practically no injury was being done to their fruit, whereas later examination often showed 15 or 20 per cent of their oranges to be injured in some way. The scattered nature of the industry was largely responsible for the crudeness with which the work was carried on. The old neighborhood competition in the production of high-grade, attractive fruit disappeared after the freeze, when the plantings were distributed so widely over central and southern Florida. Groves were more or less isolated, and a grower was frequently wholly

ignorant of the type of work being done by other producers of citrus fruits.

When the department investigations were begun it seemed almost hopeless to expect that the results of the work could be made effective. The importance of getting in touch with every grower and shipper was realized from the start, yet without some central organization through which these individuals could be reached it seemed impossible to expect that improvements in the methods of handling could be inaugurated.

The changes which have taken place in Florida during the past five years are truly remarkable. The old type of packing house has almost entirely disappeared (Pl. X, figs. 1 and 2). Modern houses, equipped with the newest machinery for handling fruit properly, have been constructed in practically every citrus district in the State (Pls. XI and XII), so that at the present time the industry is particularly well provided with the mechanical appliances for doing good work. Plate XIV shows two views of clean, well-lighted, modern packing-house interiors as contrasted with the dark and crowded rooms of the old houses (Pl. XIII). The attitude of the growers and packers has changed more slowly, however. The department has conducted a large number of field demonstrations in order to educate pickers to the necessity of careful work, and although much has been accomplished in this line, as is shown by the tabulated figures given later on, much still remains to be done. The introduction of better handling methods is largely a business problem. It has to do with the reorganization of the forces of workmen and with the method of paying them rather than with the discovery of the cause of a particular form of decay.

In California the occurrence of injury in preparing the fruit for shipment was associated with the way in which the work was done. The pickers were paid by the box, and naturally each man was ambitious to pick as many boxes as possible during the day, irrespective of the character of his work. A premium was thus placed on rough handling. Several large companies, employing hundreds of men, demonstrated that by changing from the box-payment to the day-payment plan and by insisting upon careful work they could practically eliminate all picking injuries. A change in the plan of payment is not, in itself, sufficient to bring about bet-

ter work, however; the workmen must be properly organized and supervised, and each individual picker must be held responsible for the character of his work. In California a change from the individual grower doing his own picking to the plan of association picking crews resulted in very great improvement in the character of the work. The same plan has more recently been carried out in Florida with very beneficial results.

[fol. 433] Inspections of Picking Crews and Foremen

Careful inspections of the work being done in different parts of the State have been made during practically every season since the work has been in progress. Table II and its accompanying diagram (fig. 3) show the average percentages of imperfections found in the work of a number

Fig. 3.—Diagram illustrating the percentage of imperfections in the work of a number of picking crews inspected during 1910-11 and 1911-12.

of picking crews in the course of the comprehensive field inspections made by the department investigators during the seasons of 1910-11 and 1911-12.

Table II.—Imperfections in the Work of a Number of Picking Crews Inspected During 1910-11 and 1911-12.

Class of imperfections	1910-11[1]	1911-12[2]
	Per cent	Per cent
Clipper cuts	4.2	3.3
Long stems	12.9	18.3
Pulled	2.8	2.7

Since the crews which were inspected were located in different sections of the State, the percentages given in the table and graphically shown in figure 3 as the averages of all inspections represent very closely the type of work being done throughout Florida; they indicate the necessity

[1] Averages of 64 inspections of 51 crews.
[2] Averages of 35 inspections of 34 crews.

for more careful attention to the details of picking and to the organization of the picking crews. This seems the most difficult reform to bring about, yet no permanent improvement in the carrying quality of Florida oranges will be reached until the field-handling operations are completely changed.

It is also necessary to devote more attention to inspecting the work of individual pickers. Table III and its accompanying diagram (fig. 4) show the results of the inspections

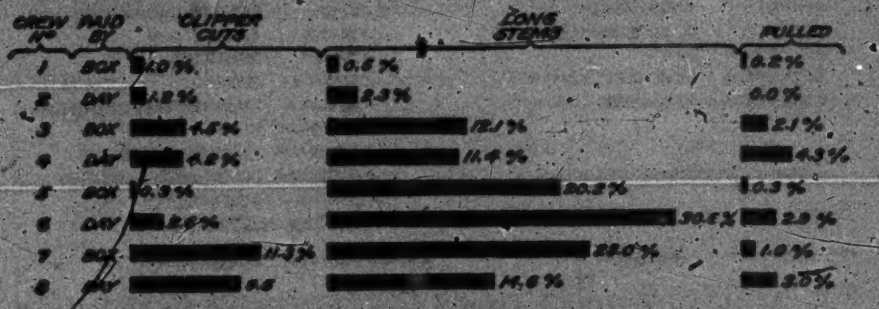


Fig. 4.—Diagram illustrating the percentage of imperfections in the work of different picking crews paid by the day and by the box, showing the variation in injury, 1910-11.

of different picking crews in different parts of the State and are presented to show that good work is possible. Crews Nos. 1 and 2 were doing practically perfect work, but the work of crews Nos. 3, 4, 5, 6, 7, and 8 was far from perfect. The percentages of long stems for which these last crews were responsible ranged from 11.4 to 30.6 per cent.

[fol. 434] Table III.—Imperfections in the Work of Different Picking Crews Paid by the Day and by the Box, Showing Variation in Injury, 1910-11

Crew No.	Paid by—	Clipper cuts	Long stems	Pulled
		Per cent	Per cent	Per cent
1	Box	1 0	0 6	0 2
2	Day	1 2	2 3	0
3	Box	4 5	12 1	2 1
4	Day	4 2	11 4	4 3
5	Box	3	20 2	3
6	Day	2 6	30 6	2 9
7	Box	11 3	23 0	1 0
8	Day	9 5	14 6	3 0

The percentages shown in Table IV and its accompanying diagram (fig. 5), which were obtained from two representative crews working in different parts of the State, give the average imperfections in the work of different individuals and show how wide a variation exists in the character of work performed.

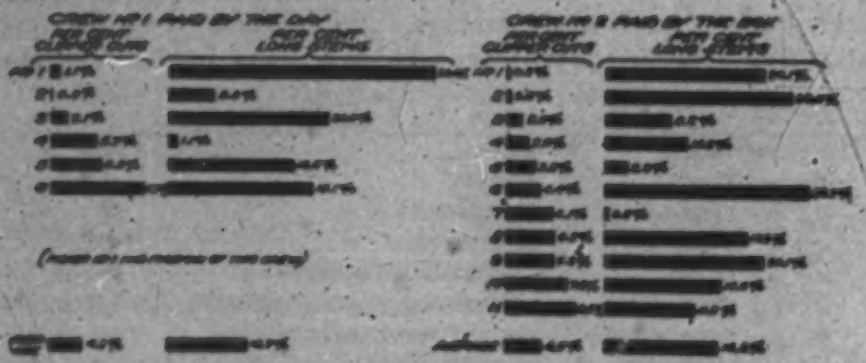


Fig. 5.—Diagram illustrating the percentage of imperfections in the work of two average picking crews, one paid by the day and one by the box, showing the variation between pickers, 1910-11.

Table IV.—Imperfections in the Work of Two Average Picking Crews, One Paid by the Day and One by the Box, Showing Variation Between Pickers, 1910-11

Crew No. 1—paid by the day			Crew No. 2—paid by the box		
Picker No.	Clipper cuts	Long stems	Picker No.	Clipper cuts	Long stems
	Per cent	Per cent		Per cent	Per cent
1[1]	1.1	33.4	1	0.5	20.1
2	0	5.3	2	.6	23.6
3	2.1	20.0	3	2.0	8.2
4	5.7	1.1	4	2.9	10.2
5	6.3	15.6	5	3.8	2.9
6	11.7	18.1	6	4.4	26.2
			7	6.1	.5
			8	6.2	17.9
			9	6.2	20.1
			10	7.8	14.6
			11	8.8	11.2
Average	4.5	15.7	Average	4.5	14.3

[1]Picker No. 1 was foreman of this crew.

[fol. 435] The figures are interesting and important because of the fact that the pickers in one crew were paid by the day while those in the other crew were paid by the box. It will be noted that there is practically no difference in the average percentages of imperfections in these two crews. In crew No. 1 the foreman was such in name only. He made no examination of the work of the men under his charge, and his own work was shown by inspection (he was picker No. 1) to be the poorest in the crew. He showed 1.1 per cent clipper cuts and 33.4 per cent long stems.

The pickers in crew No. 2, who were paid by the box, were not working with sufficient care to avoid all injury to the skin, yet the average of imperfections in the work of this crew was no greater than in the work done by crew No. 1, which was paid by the day. The simple change from the box-payment to the day-payment plan is insufficient, therefore, to bring about careful work. There must be an

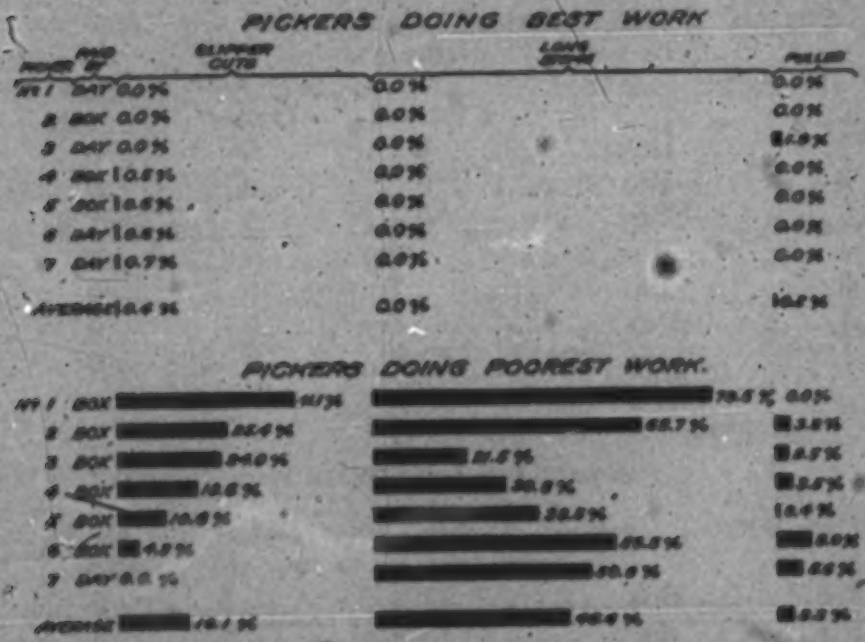


Fig. 6.—Diagram illustrating the percentage of imperfections in the work of seven pickers doing the best work and seven pickers doing the poorest work, 1910-11

efficient field foreman whose duty it is to supervise the different pickers and who must be capable of obtaining good work from them. He should watch carefully the out-

put of every laborer under his charge, should follow them to see what each is doing, and should insist upon careful handling. It is practically impossible for him to carry out these arduous duties if, in addition, he must pick fruit. It will be found profitable to engage a foreman solely for the purpose of supervising the crew and to insist that he give his entire attention to this work; if necessary, he should be prohibited from picking any fruit.

The variation in the work done by different individuals is further emphasized by the percentages shown in Table V and the accompanying diagram (fig. 6). The average of the best seven pickers is practically perfect, while the average of the seven pickers doing the most careless work shows a very high percentage of imperfections of various kinds.

[fol. 436] Table V.—Imperfections in the Work of Seven Pickers Doing the Best Work and Seven Pickers Doing the Poorest Work, 1910-11

Seven Pickers Doing Best Work

Picker No.	Paid by—	Clipper cuts	Long stems	Pulled
		Per cent	Per cent	Per cent
1	Day	0	0	0
2	Box	0	0	0
3	Day	0	0	1.9
4	Box	.5	0	0
5	do	.6	0	0
6	Day	.6	0	0
7	do	.7	0	0
Average		.4	0	.2

Seven Pickers Doing Poorest Work

Picker No.	Paid by—	Clipper cuts	Long stems	Pulled
		Per cent	Per cent	Per cent
1	Box	41.4	79.5	0
2	do	25.4	62.7	3.2
3	do	24.0	21.5	2.5
4	do	18.6	30.8	3.5
5	do	10.8	38.5	.4
6	do	4.3	56.5	8.0
7	Day	0	50.8	5.6
Average		16.1	45.4	3.3

The importance of thoroughly inspecting the crews and of training the foremen to insist upon careful work is further emphasized by the percentages shown in Table VI and its accompanying diagram (fig. 7). These figures reveal very little difference in the averages of crews paid by the

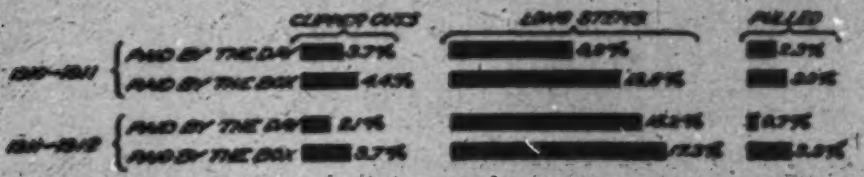


Fig. 7.—Diagram illustrating the percentage of imperfections in the work of crews paid by the day and by the box; average of all inspections, 1910-11 and 1911-12.

day and those paid by the box, proving that by means of careful supervision a conscientious foreman can get as good work from pickers under the box-payment plan as a more lax foreman can obtain under the day-payment plan. The efficient foreman is therefore the best solution of this problem.

Table VI.—Inperfections in the Work of Crews Paid by the Day and by the Box; Average of all Inspections, 1910-11 and 1911-12

Class of imperfections	1910-11		1911-12	
	Crews paid by day [1]	Crews paid by box [2]	Crews paid by day [3]	Crews paid by box [4]
	Per cent	Per cent	Per cnet	Per cent
Clipper cuts	3.7	4.4	2.1	3.7
Long stems	9.9	13.8	15.2	17.3
Palled	2.2	3.0	.7	3.3

Table VII and figure 8 show the averages of imperfections in the work of five of the best and five of the poorest picking crews inspected during 1910-11 and 1911-12.

---

[1] Average of 18 inspections.
[2] Average of 46 inspections.
[3] Average of 8 inspections.
[4] Average of 27 inspections.

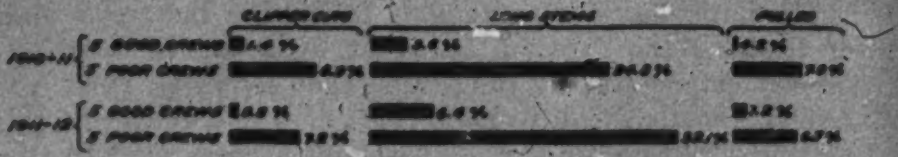


Fig. 8.—Diagram illustrating the average percentage of imperfections in the work of five picking crews doing good work as compared with five picking crews doing poor work, 1910-11 and 1911-12

[fol. 437] Table VII.—Imperfections in the work of five picking crews doing good work as compared with five picking crews doing poor work, 1910-11 and 1911-12.

Class of imperfections	1910-11		1911-12	
	Five good crews	Five poor crews	Five good crews	Five poor crews
	Per cent	Per cent	Per cent	Per cent
Clipper cuts	1.4	8.9	0.8	7.2
Long stems	3.6	24.8	6.4	32.1
Pulled	.2	7.9	1.2	6.7

Along with the inspections of the work of the crews and the individual pickers, an attempt was made to demonstrate the practicability of training workmen to use more care. The workers of the Bureau of Plant Industry kept in close touch with the foreman of a representative picking crew, taking pains to indicate to him the scope and character of the inspections which it was desirable for him to make. In Table VIII and figure 9 are shown the results of work

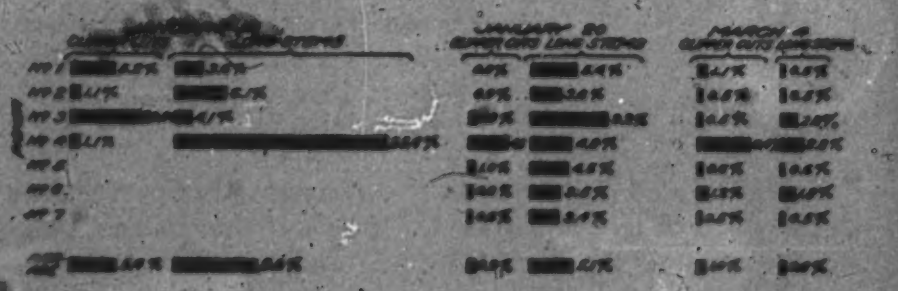


Fig. 9.—Diagram illustrating the percentage of imperfections found during three inspections of one picking crew ranging from three to seven persons, showing great improvement.

of this character. The first inspection was made on January 14, when the crew consisted of four men, the average of imperfections at that time being 5.4 per cent clipper cuts and 9.9 per cent long stems. The importance of careful work was urged upon the foreman and crew, and when on January 20 a second inspection was made, a very material decrease was found in the percentages of imperfections. The crew had been increased to seven by that time, and the average of clipper cuts was 0.9 per cent and of long stems 5.1 per cent. After an additional demonstration of the effects of rough handling, no examination of the work of the crew was made until March 4, when the third and last inspection of the season was made. The average percentages of the seven pickers composing the crew on that date were 1 per cent clipper cuts and 0.6 per cent long stems. An examination of the work of the different individuals shows that one man (picker No. 4) was doing practically all of the clipper cutting, his average being 6.4 per cent; it will also be noted that his average of long stems (2.8 per cent) was greater than that of any of the other pickers. If it was impossible for this workman to improve the character of his picking he should have been discharged. Without him the average percentage of clipper cuts would have been reduced to 0.7 per cent and of long stems to 0.5 per cent.

[fol. 438] Table VIII.—Imperfections found during three inspections of one picking crew, showing great improvement.

Picker No.	Jan. 14, 1911		Jan. 20, 1911		May 4, 1911	
	Clipper cuts	Long stems	Clipper cuts	Long stems	Clipper cuts	Long stems
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1	5.2	3.6	0	5.4	1.1	0.5
2	1.1	6.1	0	3.6	.5	.5
3	9.5	4.1	1.0	9.2	.5	2.0
4	1.1	25.4	4.8	4.8	6.4	2.8
5	...	.....	1.0	4.5	.6	.6
6	...	.....	.8	3.5	1.2	1.8
7	...	.....	.6	3.4	.5	.5
Average	5.4	9.9	.9	5.1	1.0	.6

While these figures plainly demonstrate the practicability of training a crew of pickers to do careful work, permanent improvement can not be accomplished without con-

tinuous attention to the details of inspection and constant urging of the workmen to better efforts. There are cases where picking operations were improved as long as the men thought that inspections would be made; as soon as these were discontinued, however, it frequently happened that the character of the work changed, and injuries again became common. Continual vigilance is therefore the prime requisite for carrying on picking operations in such a way that the number of injuries can be held at a minimum.

Proper Field Equipment

The efficiency of the foreman and of the picking force in general is frequently lowered by poor field equipment. In some instances associations of Florida growers have spent large sums in building and equipping modern packing houses, while their field outfits and methods have been neglected and consequently are so crude that the expensive packing-house equipment is of practically no value in so far as careful handling of the fruit is concerned.

A frequent source of injury is the clipper. Unless the shears are systematically inspected by the foreman they soon become dull and loose at the joint, and clipper cuts and long stems are almost sure to follow. It has not been uncommon to see a crew of clippers using clippers so dull and worn that it was impossible to make a close, clean cut. Clippers with rounded or blunted points should also be supplied in order to run no risk of puncturing the fruit.

The type of picking receptacle used is fundamentally important. Next to poor clippers, probably more injury is caused by poor picking sacks than by any other form of equipment. The old type of gunny sack, holding from three-fourths of a box to a full box of fruit, is still in use to some extent. Such a sack is so long that it is almost impossible to avoid pressing it against the ladder and branches. Moreover, it is made of such loosely woven material that the fruit may easily be punctured by thorns or twigs, and it is so heavy and unwieldy when filled with fruit that the picker can not always prevent injuries of this kind. The most objectionable feature, however, is the fact that the fruit must be emptied through the top of the sack into the field box, and even with the best of care the oranges must drop a foot or more when emptied in this way.

The best type of sack is one which opens at the bottom, so that it may be placed in the field box before being emptied and the fruit allowed to roll out gently without any appreciable drop. The mouth should be partly closed, so as to make it impossible for the picker to toss or drop the fruits into it. The material of which it is made should be [fol. 439] heavy enough to protect the fruit from thorns or twigs, and the capacity should not be more than half that of a large, standard field box. With a bag of this size and texture it is comparatively easy for the picker to protect the fruit from bruising against the ladder or branches. The wicker basket in use in some districts is supposed to prevent injuires from pressure, but it has several objectionable features. It is, first of all, awkward to handle. The wide mouth is an additional disadvantage, as it tempts the picker to drop the fruit; moreover, the large open baskets have no equals as collectors of dry twigs, leaves, and other trash. Some baskets open at the bottom, but from most of them the oranges must be emptied through the top, thus entailing a considerable drop.

The defects of the ordinary field box have already been discussed. Smaller boxes made of lighter material than those now used in most groves are to recommended.

Influence of Cleaning Operations Upon Decay

Necessity for Washing

On account of the wide distribution throughout Florida of the white fly and its attendant sooty mold, the washing of citrus fruits has become a necessity in most sections of the State. In some localities where the fly has not yet become prevalent washing is practiced in order to give the fruit a higher polish and to improve its appearance. The removal of dust and stains can be equally well accomplished by dry brushes, however, and the risk of infection is not so great. During the past few years there has been a great increase in the proportion of fruit washed or otherwise cleaned until now the practice is very general throughout the State. The investigations of the Bureau of Plant Industry included a study of the relationship of washing or other cleaning operations to the amount of decay developing after the fruit is

packed, and the results indicate that the extent of the deterioration from decay varies with the character of the work done in the cleaning processes. As a general rule, any operation to which the fruit is subjected increases the chance for injury and consequent decay. Well-grown fruit, comparatively free from stain or rust, is sufficiently attractive without being cleaned. Demonstrations with both California and Florida citrus fruits have shown that receivers in eastern and northern markets can not distinguish between washed and unwashed packs if the fruit is at all clean when it comes from the grove. From the viewpoint of the effect of any particular operation upon the subsequent behavior of the fruit, the soundest policy is one which will reduce to the lowest possible minimum the processes to which the fruit is subjected in the course of its preparation for shipment. Washing is perhaps the severest treatment that can be given to citrus fruits, and wherever it is not absolutely necessary in order to render the fruit marketable it should be omitted. When oranges have been exposed to attacks of the white fly, washing or some other cleaning process is imperative because of the sooty mold, consequently a large proportion of the fruit must always be subjected to this treatment. The importance of having the work carried on in such a way that as little damage as possible will result becomes doubly urgent when it is considered that the washing processes offer ideal conditions for the spread of blue mold.

Wherever washing and subsequent drying are practiced, the combined operations are the most complicated processes through which the fruit is put in the packing house. They involve extra handling of the fruit and accordingly furnish additional opportunities for mechanical injury. The results of the bureau investigations clearly show that decay in the packed fruit is largely due to injuries received or aggravated during the operations of washing and drying, although it is difficult, if not impossible, to indicate any particular point at which most of the injury takes place. The results of the Florida experiments show that where injuries to the fruit were confined almost wholly to [fol. 440] those received in the commercial field-handling operations the decay was practically the same as in the case of lots where injuries were confined to those received in the washing and drying operations. From this the as-

sumption may be drawn that the bad effects following washing are due not so much to actual injuries made in passing the fruit through the machine as to the inoculation of injured and bruised spots through the agency of dirty, infected water. There seems to be a definite relationship between the type of field handling and the occurrence of decay following washing. Injuries made in the grove, punctures from long stems, or other damage received as the oranges pass through the machinery are aggravated by the addition of moisture, especially when the water is not clean. On the other hand, the quality of work performed by the machinery is largely dependent upon the manner in which the fruit is handled in the grove, and this consideration emphasizes the necessity of careful and systematic methods, especially where washing must be employed. Fruit which is handled in groves and packing houses with sufficient care to insure its packing without injury usually shows much less decay after washing than the same or similar fruit which has been treated less carefully.

Fruit which is covered with sooty mold must be thoroughly soaked before it is in proper condition for washing. This introduces a prolific source of infection—the soaking tank. Unless the water in the soaking tank is kept sanitary by being frequently changed, it soon becomes heavily charged with blue-mold spores, and is then one of the most dangerous features of the washing operations. As yet, no disinfectant has been found which proves effective against blue mold. Extensive investigation of this phase of the

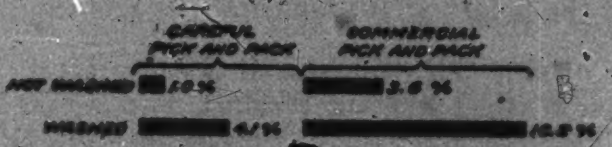


Fig. 10.—Diagram illustrating the percentage of blue-mold decay after holding oranges, washed and not washed, for two weeks in a packing house; summary of all experiments, 1910-11.

subject has shown the spores to be so resistant that any solution used to destroy them must be of sufficient strength to injure the surface of the fruit. The importance of maintaining the soaking tank in a sanitary condition is there-

fore fundamental. It should be emptied frequently, and sprays of fresh water should be directed against the fruit as it passes through the washing machine.

Results of Washing Experiments

Tables IX, X, and XI, and figures 10, 11, and 12 show the results obtained during the season of 1910-11, when the washing experiments of the bureau were carried on in a comprehensive and systematic manner, giving the average percentages of decay found in carefully and commercially handled fruit, washed and not washed, respectively. The fruit was packed as if for shipment, but instead was held for two weeks in the packing houses and the percentages of decay determined by actual count. Table IX and its accompanying diagram (fig. 10) present a summary of all the washing experiments carried on during the season, including the work of 13 different types of machines operated in 32 packing houses. The figures show the relative increase in decay due to the washing operations alone in the case of the carefully handled fruit and to the combination of causes in the case of the commercially handled fruit. The carefully handled oranges, not washed, showed 1 per cent of decay after two weeks; the washed, 4.1 per cent. In the commercially handled lots, the fruit not washed showed 3.6 per cent of decay and the washed fruit 10.2 per cent. The figures include the results of work done in many different ways, and while they summarize the general effects of washing, some analysis of the data is necessary in order to bring out the points of fundamental importance.

[fol. 441] Table IX.—Blue-mold Decay after Holding Oranges, Washed and Not Washed, Two Weeks in Packing House; Summary of All Shipments, 1910-11.[1]

Treatment	Careful pick and pack	Commercial pick and pack
	Per cent	Per cent
Not washed	1.0	3.6
Washed	4.1	10.2

[1] Results of 37 experiments in 32 packing houses, in which 13 different types of washers were used.

Table X and its accompanying diagram (fig. 11) show the wide variation in the amount of decay found in five houses selected for careful work, as compared with five houses chosen for rather careless work. While the average percentages of decay in the washed fruit of the five better houses were only slightly higher than the percentages of decay in the fruit not washed, it will be noted that the cleaning operations in the five careless houses increased the amount of decay to a material extent, even in the carefully picked and packed fruit. The significant point to be noted in these results is that the washing operations were conducted in the careful houses in such a way that little or no harm ensued, while in the more careless houses they were followed by serious injury. It is impossible to state definitely whether this result was due to the use of different types of machines or to the more careful operation of the machinery in the five best packing houses. It is probable,

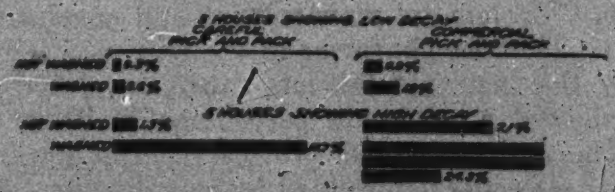


Fig. 11.—Diagram illustrating the percentage of blue-mold decay appearing after holding oranges, washed and not washed, for two weeks in a packing house, showing high compared with low decay in carefully handled and commercially handled fruit.

however, that both factors were in some degree responsible. Observation has shown that careless manipulation of the best machinery is frequently followed by as serious deterioration of the fruit as is the careful handling of less desirable types of machines.

Table X.—Blue-mold Decay after Holding Oranges, Washed and Not Washed, Two Weeks in a Packing House, Showing High and Low Decay in Fruit Carefully Handled and Commercially Handled, 1910-11.

Packing houses and treatment	Careful pick and pack	Commercial pick and pack
	Per cent	Per cent
5 houses showing low decay:		
Not washed	0.3	0.9
Washed	.6	1.9
5 houses showing high decay:		
Not washed	1.3	7.1
Washed	10.7	24.3

In order to bring out the relationship between field handling and packing-house management, Table XI and its accompanying diagram (fig. 12) are presented. These give the results of experiments made at the same time in two houses in the same locality, the character of fruit handled in both houses being practically identical. Observation showed that the work of house No. 1 was careless, while in house No. 2 systematic management and careful methods prevailed. That the character of the fruit was the same is shown by the fact that the lots carefully picked and not washed showed a minimum percentage of decay in both cases. The fruit was held two weeks after packing, and [fol. 442] decay was determined by actual count. In house No. 1, the carefully handled fruit, not washed, was held for two weeks with only 1.1 per cent of decay, while the washed lot of the same fruit developed 14.1 per cent. The carefully handled oranges, not washed and washed, showed 0.8 per cent and 1 per cent of decay, respectively, in house No. 2. The commercially handled fruit, not washed, in house No. 1 developed 4.7 per cent of decay after two weeks, while in house No. 2 this class of fruit showed only 1.2 per cent of

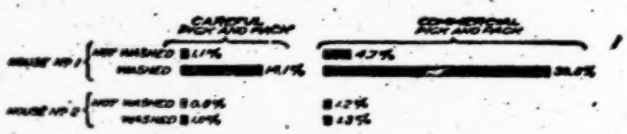


Fig. 12.—Diagram illustrating the percentage of blue-mold decay in oranges, washed and not washed, from two houses in the same locality, after holding the fruit for two weeks in the packing houses, 1910-11.

decay. There was 39.5 per cent of decay in the washed lots of commercially handled fruit from house No. 1, but in

house No. 2 only 1.3 per cent of the fruit handled in the same way showed decay at the end of two weeks. The significance of the effects of rough field handling and subsequent poor manipulation of the machinery is amply shown, and the practicability of carrying on washing operations with care sufficient to reduce decay to a minimum is likewise demonstrated.

Table XI.—Blue-mold Decay in Oranges, Washed and Not Washed, from Two Houses in the Same Locality after Holding the Fruit for Two Weeks in the Packing Houses, 1910-11.

Packing houses and treatment	Careful pick and pack	Commercial pick and pack
	Per cent	Per cent
House No. 1:		
Not washed	1.1	4.7
Washed	14.1	39.5
House No. 2:		
Not washed	0.8	1.2
Washed	1.0	1.3

In the bureau investigations 12 different types of washing machines and one sawdust cleaner were used. A few of the machines were of such evident impracticability that they were rapidly going out of use, and of those which gave satisfactory results it is manifestly impossible to name any one which is best suited for all purposes. The quantity of fruit to be handled and the nature of the work to be performed are important factors which must be considered in determining the value of any machine. When purchasing this part of the equipment, it is important to choose the type of machine which will do the best work from the standpoint of careful handling and will eliminate, as far as is possible, the detrimental results of washing.

Some of the features which should be avoided in washing machines are as follows:

(1) Completely inclosed brushes. The fruit should be in plain sight at all times.

(2) Pressure on the fruit other than that afforded by the weight of the fruit itself.

(3) Opportunity for the fruits to tumble over or rub against one another to any great extent.

(4) Any arrangement of brushes, mats, etc., which allows twigs, thorns, nails, etc., to become lodged in the runway through which the fruit must pass.

Any one of these features may be the means of much injury, especially in houses where careful attention to the operation of the machinery is not given at all times, or where the field-handling operations have been more or less careless.

Importance of Drying

Fruit should never be packed while moist or wet. Moisture is one of the prime requisites for the development of decay, and, as the temperature of the fruit during the Florida packing season is usually high enough to facilitate [fol. 443] the germination of the mold spores the importance of having the fruit perfectly dry can not be too strongly emphasized. Weather conditions in Florida are practically never such that fruit may be allowed to stand wet in the boxes for several days, although this practice prevails to some extent in California. The wet conditions within the mass of fruit renders ideal the conditions for the development of any mold, especially where the packing-house premises are not strictly sanitary. Injured fruits handled in this way frequently develop decay which has not advanced far enough to be detected when the fruit passes over the grading belts and which might have been prevented by prompt drying. Later drying or even icing in transit can not entirely arrest the growth of the mold.

In some districts the sun rack (Pl. VII, fig. 2) is depended upon for drying the fruit, and with favorable weather conditions this method is as effective as the use of many of the so-called artificial-drying machines. The chief objection to this rack is that frequently sufficient space for its proper construction is not available, and it is therefore not made large enough to accommodate all of the fruit or to insure perfect drying. Moreover, the handling of the fruit on this rack is often very rough and conducive to severe injury, unprotected brooms or wooden implements being generally used to dislodge the fruit or to spread it over the rack as it comes from the washing machine. Another point of injury is where the fruit is allowed to run off the bottom of the rack into the field boxes, from which it is again emptied

into a hopper leading to the grading machine. These various operations and the more or less rough type of handling greatly multiply the chances for injury and increase the liability of blue-mold infection.

The drying of fruit in Florida is difficult at best, and the artificial drier seems to be an ultimate necessity, at least from the standpoint of thorough work and careful handling. Frequently weather conditions are such that complete drying is practically impossible unless some artificial method is devised to evaporate the water from the surface of the fruit. A properly constructed drying machine can be adjusted so as to carry the fruit continuously from the washing machine to the grading belts, without drops, gravity runs, elevators, or even the use of the human hand. A machine which can thus be adjusted to carry on the work with proper care is more reliable than are workmen of the type usually employed in a packing house.

The artificial drying of fruits is still in the experimental stage in Florida, and a machine which will prove wholly satisfactory under all conditions has not yet been devised. All the types of mechanical driers have yielded good results under favorable weather conditions and all have given more or less trouble on cloudy days or at any time when the humidity was very high.

In the most effective driers now in use, an air blast is circulated around the fruit in such a way that the moisture is more or less completely removed. The introduction of artificial heat or some other means of drying the circulating air will greatly improve the character of the work and will materially lessen the distance over which the fruit must travel. Other things being equal, the more promptly the drying can be accomplished the less chance there will be for the development of blue mold.

Packing and Shipping Experiments

Experimental Consignments During Two Seasons

During the seasons of 1910-11 and 1911-12 comprehensive series of shipping experiments were made in order to demonstrate the application of the results of the packing-house tests made during previous years. More than 90 experimental shipments of oranges were made from Florida in 1910-11, and 65 shipments were sent out in the course of the work during 1911-12. These consignments were com-

posed of fruit from practically every orange-growing district in the State, including the Manatee River district, the Pinellas Peninsula, and the Hillsboro County sections on the west coast; the groves extending from Fort Myers to [fol. 444] De Land in the interior; and the section along the east coast from Daytona and New Smyrna to Miami. They represented a great variety of conditions and formed a fair average of the character of the fruit in the State, as well as of the manner in which it was prepared for market under commercial conditions. Some of the best as well as some of the poorest houses were represented in these tests, and a number of houses which may be classed as average were also included.

Each shipping series consisted of six boxes of oranges; two of these were carefully picked, graded, and packed by the bureau workers; two were picked by regular pickers but were carefully graded and packed; and the last two were taken from the ordinary commercial run of the houses from which the experimental shipments were made. The shipments were divided into two parts. In one the grading, packing, and shipping were made on the same day on which the fruit was picked, or as soon afterwards as possible, and in the other the same fruit was held for three or four days in the packing house before packing and shipping. The former were designated as "immediate" and the latter as "delayed" shipments. All lots were sent out with the regular carloads of fruit from the various packing houses, and the experimental boxes were expressed to Washington from the northern markets to which the cars were consigned. Each box was inspected on the day of arrival in Washington and the percentage of decay accurately determined. The fruit was held for three weeks under ordinary open-market conditions, and inspections were made at the end of the first, second, and third weeks. The results obtained give a fair representation of the average decay occurring in a commercial pack and show the percentage of loss which can be avoided by more careful handling.

Plate XV illustrates the condition in which the three lots shipped from one packing house using very little care arrived on the Washington market. The carefully picked, graded, and packed fruit (on the left in the illustration) showed 4 per cent of decay on arrival; the commercially

picked but carefully graded and packed fruit (in the center) showed 35.6 per cent of decay, and the commercially handled fruit (on the right) had 65.9 per cent of decay. After intervals of one, two, and three weeks the three lots, respectively, showed decay as follows: After one week, 4 per cent, 46 per cent, and 71.6 per cent; after two weeks, 11.5 per cent, 54 per cent, and 72.2 per cent; after three weeks, 11.5 per cent, 57.1 per cent, and 72.2 per cent.

Table XII and figure 13 show the average percentages of decay found in the shipments during 1910-11 and 1911-12.

Table XII.—Blue-mold Decay in Oranges Carefully Handled and Commercially Handled, on Arrival in Washington and After Holding for Three Weeks; Average of All Inspections, 1910-11 and 1911-12.[1]

Time of examination	Careful pick and pack		Commercial pick and careful pack		Commercial pick and pack	
	1910-11	1911-12	1910-11	1911-12	1910-11	1911-12
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
On arrival	0.6	0.6	2.5	1.4	7.0	4.0
After 1 week	1.1	.9	4.3	2.0	10.8	6.8
After 2 weeks	1.6	1.4	5.5	3.5	13.1	10.4
After 3 weeks	1.9	2.2	6.1	5.5	14.2	14.2

Table XIII and its accompanying diagram (fig. 14) summarize the results of the two seasons' work and show the average of all experiments carried on during the two years. In the illustration the results are marked as curves, using the percentages of decay for the vertical lines and the times of arrival and of holding for the horizontal lines. In this way the progress of the deterioration can readily be traced, and the influence of the different systems of handling upon the occurence of decay is strikingly shown. [fol. 445] The carefully handled fruit arrived in Washington during both seasons with less than 1 per cent of decay, or an average for the two years of 0.6 per cent. The commercially picked but carefully packed fruit showed much more decay on arrival, while a still higher percentage of decay had developed in the fruit picked and packed under ordinary commercial conditions. The average percentage of decay which was developed in the carefully picked and packed fruit during a holding period of three weeks was

[1] From 79 comparable shipments made in 1910-11 and 65 comparable shipments made in 1911-12.

about the same as that shown on arrival by the commercially picked but carefully packed lots. The fruit handled under commercial conditions throughout had developed more than

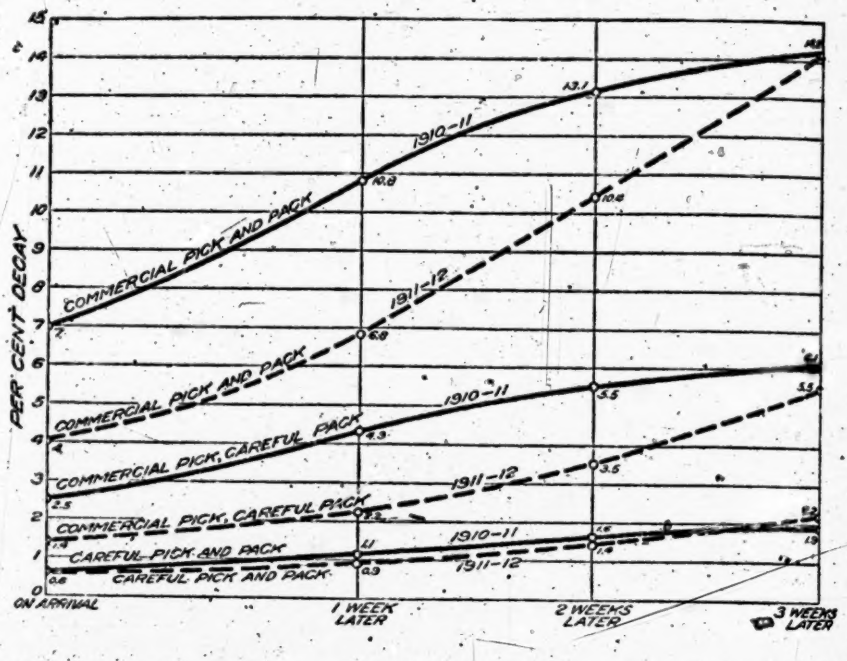


Fig. 13.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges on arrival in Washington and after holding for three weeks; average of all inspections, 1910-11 and 1911-12.

twice as much decay by the first inspection as occurred in the carefully picked and packed fruit at the end of three weeks. The latter boxes, with 2.1 per cent of decay, were still in good marketable condition after holding for three weeks under ordinary market conditions, but the commercially handled fruit had developed 5.5 per cent of decay on arrival, which was increased to 14.2 per cent at the end of three weeks.

Table XIII.—Blue-mold Decay in Oranges Carefully Handled and Commercially Handled, on Arrival in Washington and After Holding for Three Weeks; Summary of the Results of the Two Seasons' Work, 1910-11 and 1911-12[1]

Time of examination	Careful pick and pack	Commercial pick and careful pack	Commercial pick and pack
	Per cent	Per cent	Per cent
On arrival	0.6	2.0	5.5
After 1 week	1.0	3.3	8.8
After 2 weeks	1.5	4.5	11.8
After 3 weeks	2.1	5.8	14.2

[fol. 446] These results strongly emphasize the very definite relationship which exists between the type of handling

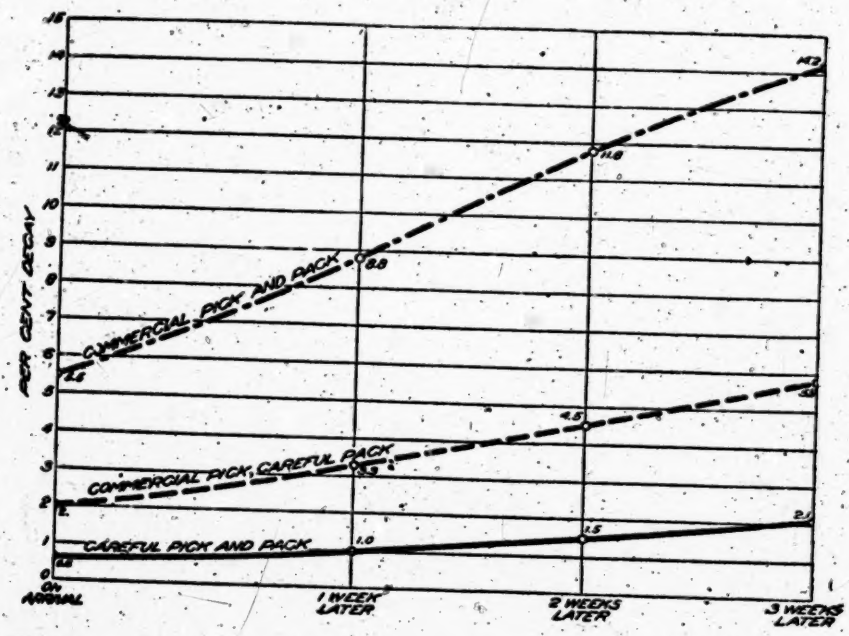


Fig. 14.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges on arrival in Washington and after holding for three weeks; summary of the results of the two seasons' work, 1910-11 and 1911-12.

[1]From 79 comparable shipments made in 1910-11 and 65 comparable shipments made in 1911-12.

given the fruit in preparing it for shipment and its behavior during transit, and they show that the condition of the fruit after arrival in market depends largely upon the character of the work done in the grove and the packing house. They also show that the Florida orange, when properly handled, has excellent shipping qualities and that practically all loss from blue-mold decay, such as has occurred in the past, can be eliminated. This is the fundamental factor upon which will eventually depend the successful marketing of the crop as well as the extension of the territory over which sound fruit can be distributed. The importance of having the fruit remain in good condition after arrival in market is most urgent. Carefully handled fruit which has good keeping quality will always command a premium over fruit which has a bad reputation. The former will enable buyers to break up carloads and to ship sound fruit to smaller markets over an area two or three times as large, while fruit of a less desirable quality must be consumed quickly in order to avoid further serious loss. Moreover, aside from the actual saving of fruit, the reputation of a brand which holds well on the market cannot be adequately estimated in dollars and cents.

Effect of Delayed Shipment

Experiments with delayed shipments were made in order to determine the effect of "curing" fruit before packing. One of the strongest traditions which existed among packing-house men in the past was that curing was necessary in order that the fruit might be in proper condition for packing. The slight wilting and consequent softening of the oranges was supposed to enable the packer to place them more firmly in the box. The results of the shipping experiments carried on during the two seasons did not show that there was any advantage to be gained from curing. Contrary to the general belief that cured fruit is less easily injured in packing, the average decay in the delayed lots was considerably higher than in the immediate shipments. Table XIV and figures 15, 16, and 17 give the average per- [fol. 447] centage of decay found in the immediate and delayed shipments during the seasons of 1910-11 and 1911-12. Sufficient data have been accumulated to indicate that care-

fully handled fruit may be cured without serious loss, but that wherever the fruit has been appreciably damaged in the course of its preparation for shipment, decay is materially greater in the delayed lots. The carefully handled immediate and delayed shipments during 1910-11 and 1911-12 arrived with 0.5 per cent and 0.7 per cent of decay, respectively, the difference being so slight that it may be neglected entirely. The commercially handled immediate shipments showed 4.6 per cent of decay and the delayed

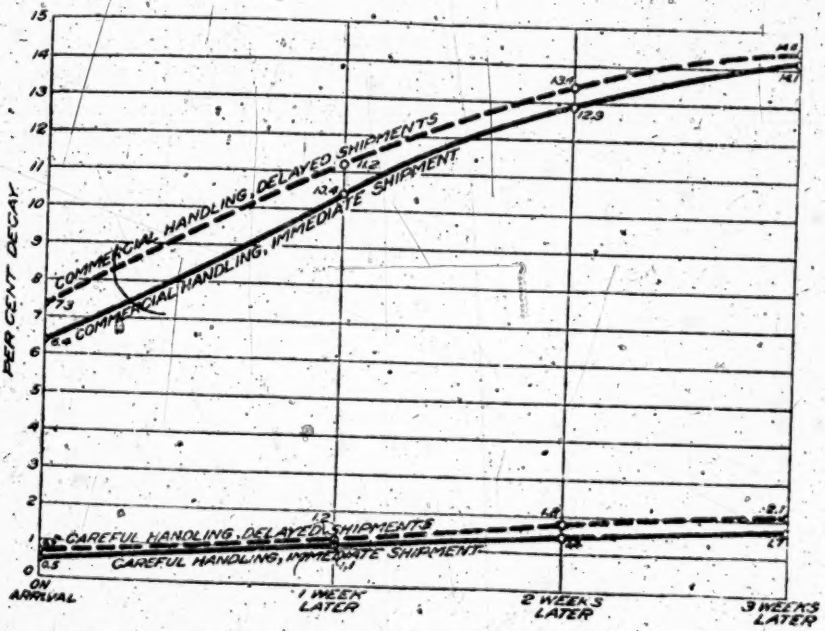


Fig. 15.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments, 1910-11.

ones 6.6 per cent on arrival. After holding these lots of fruit for three weeks the decay in the carefully handled fruit had increased to 2 per cent, while the commercially handled shipments showed 13.8 per cent of decay for the immediate and 14.8 per cent for the delayed ones. Once again the effect of careful handling upon the behavior of the fruit after arrival in market is strikingly shown.

Table XIV.—Blue-mold Decay of Oranges on Arrival in Washington and After Holding for Three Weeks, in Carefully Handled and Commercially Handled and in Immediate and Delayed Shipments, 1910-11 and 1911-12[1]

Time of examination	Careful pick and pack			Commercial pick and pack		
	1910-11	1911-12	Average 2 seasons	1910-11	1911-12	Average 2 seasons
On arrival:	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Immediate ..	0.5	0.5	0.5	6.4	2.9	4.6
Delayed	.7	.7	.7	7.3	5.8	6.6
After 1 week:						
Immediate ..	1.1	.9	1.0	10.4	5.7	8.1
Delayed	1.2	1.0	1.1	11.2	8.7	9.9
After 2 weeks:						
Immediate ..	1.4	1.4	1.4	12.9	9.7	11.3
Delayed	1.8	1.5	1.7	13.4	11.7	12.5
After 3 weeks:						
Immediate ..	1.7	2.3	2.0	14.1	13.5	13.8
Delayed	2.1	2.0	2.1	14.4	15.1	14.8

[fol. 448] The prevailing opinion that fruit packed soon after picking or before it has had time to cure will arrive in slack condition has not been borne out by the bureau investigations. When the fresh fruit is firmly and properly placed in the box, it is no more liable to make a slack pack than is the cured fruit. It is probably true that the latter can be more easily packed, for less effort is required to press it into the box. The work of many rapid packers who make no effort to place the oranges firmly and who rely upon the press to squeeze the fruit into place, is conducive to poor carrying quality as well as to slackness. Each layer must be properly placed. Where the press is depended upon to shove the fruit down into the box the force exerted reaches through only two or three layers and often squeezes the oranges in these to the extent of breaking the skin or inflicting serious bruises. After the boxes are loaded on the cars, jolting during transit loosens the improperly packed layers, and the fruit arrives on the market in a slack condition. When every orange is firmly placed, however, there is little chance that such slackening will result.

Moreover, fruit held loose in the packing house during warm, humid weather is afforded an additional opportunity for blue-mold infection. Although some packers consider

[1] From 39 comparable shipments made in 1910-11 and 28 comparable shipments made in 1911-12.

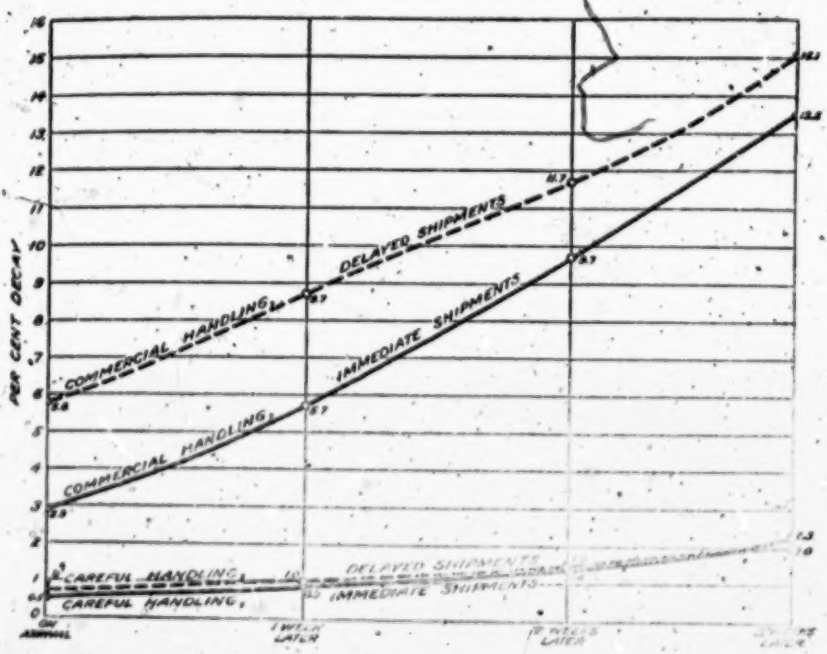


Fig. 16.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments, 1911-12.

this delay necessary in order to eliminate the injured oranges which have begun to decay, experience and observation show that while graders are occasionally able to discern and throw out such fruits, it is practically impossible to discover all infected specimens. The development of blue mold during the curing period accounts for the advanced stages of the decay usually found in delayed shipments on arrival in market.

The average length of time during which the experimental shipments were in transit from Florida to Washington was 10 days; as a rule, from 8 to 10 days are required for Florida oranges to arrive at their destination. Several days may then elapse before the fruit is sold, and a still longer period usually intervenes before it is placed in the hands of the consumer. The 3-weeks' period used in the Washington market-holding tests represents approximately the length

of time required to finally dispose of the fruit. When the [fol. 449] fruit is held for 3 or 4 days in the packing house the period elapsing between picking and final consumption is unnecessarily and even dangerously lengthened. From this standpoint alone curing is unwise, as the delay increases the chance for the infection of bruises or injured spots and facilitates the development of decay before shipment and in transit.

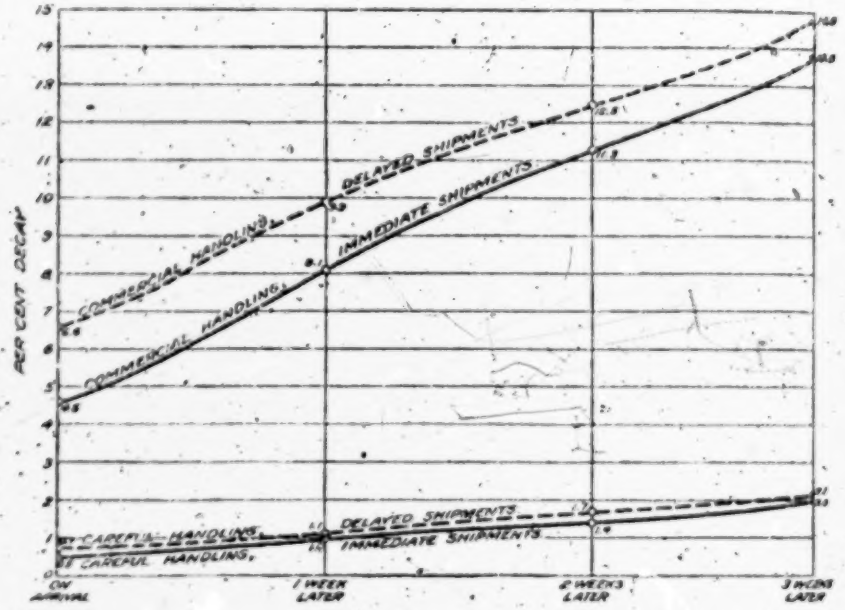


Fig. 17.—Diagram illustrating the percentage of blue-mold decay of oranges, on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots and in immediate and delayed shipments; average of the two seasons, 1910-11 and 1911-12.

A comparison of commercially handled and immediate and delayed shipments from two packing houses, in one of which the work was being done very carefully, while in the other the handling was of a rather rough character, emphasizes the relationship which exists between delay and the occurrence of decay while in transit. Table XV and its accompanying diagram (fig. 18) give the results of commercial shipments from these two packing houses during the season of 1910-11. The houses were located in the same district and the fruit was similar in character.

Table XV.—Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, the immediate and delayed shipments from two houses, 1910-11.

	House No. 1		House No. 2	
	Immediate	Delayed	Immediate	Delayed
Time of examination	Per cent	Per cent	Per cent	Per cent
On arrival	0	0	26.1	67.3
After 1 week	1.2	6	40.4	71.3
After 2 weeks	3.1	1.4	42.6	71.9
After 3 weeks	4.0	1.4	42.8	71.9

The fruit from house No. 1, which was carrying on the work in a careful manner, arrived in Washington with no decay in either immediate or delayed lots, and after holding for three weeks the immediate shipments developed 4 per cent of decay, while the delayed ones had less than 2

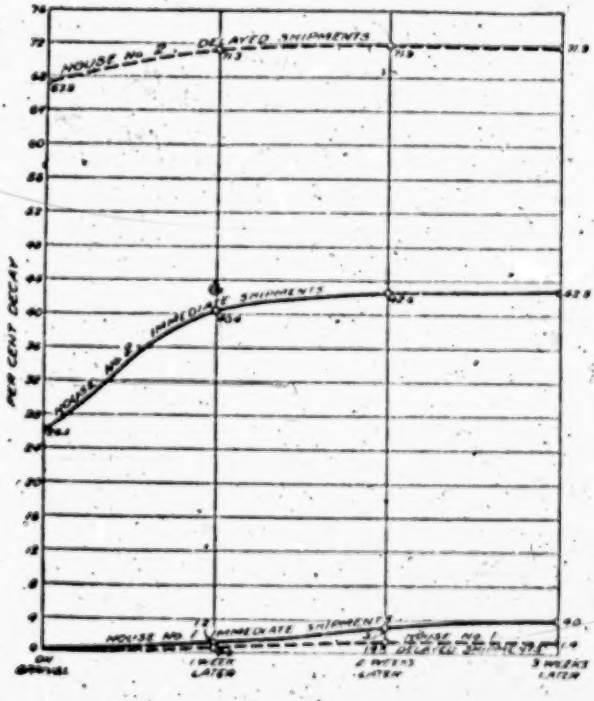


Fig. 18.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in immediate and delayed shipments from two houses, 1910-11.

per cent. In house No. 2, where the work was being carelessly done, the difference between the percentages of decay [fol. 450] was very great. It will be noticed that even in the immediate shipments the proportion of decayed oranges amounted to 26.1 per cent on arrival and at the end of three weeks constituted 42.8 per cent of the total. In the delayed shipments, 67.3 per cent of decay had developed on arrival, and this was increased to 71.9 per cent after three weeks. This is an extreme case, of course, and it is only fair to state that few houses in Florida were doing as poor work as this during 1910-11. The figures are presented to emphasize the contrast between commercial work performed under different conditions.

Table XVI and its accompanying diagram (fig. 19) give the results of immediate and delayed shipments of fruit from a single packing house during the period when high decay is usually most prevalent in Florida. The work done in this house could not be considered as first class. For the sake of contrast, immediate and delayed lots carefully handled by the bureau workers were sent out at the same time as the commercially handled shipments. The carefully handled fruit, shipped immediately, arrived in Washington with 1 per cent of decay, while the commercially handled oranges showed 5.1 per cent. The carefully handled delayed lot had developed 3.6 per cent of decay on arrival while the commercially handled delayed shipment showed 36.9 per cent at the same time. After holding the carefully handled fruit in Washington for three weeks, the immediate shipment was still in very good marketable condition with only 2 per cent of decay, whereas the percentage in the delayed lot had increased to 6.3. The latter fruit was still marketable, although subject to discount. Both lots of commercially handled fruit, however, developed decay far in excess of any market allowance, the immediate lot showing 25.6 per cent and the delayed 44 per cent.

Table XVI.—Blue-mold decay of oranges in immediate and delayed shipments from one house, on arrival in Washington and after holding for three weeks during a period of high blue-mold decay, December, 1911.

	Carefully handled fruit		Commercially handled fruit	
Time of examination	Immediate	Delayed	Immediate	Delayed
	Per cent	Per cent	Per cent	Per cent
On arrival	1.0	3.6	5.1	36.9
After 1 week	1.0	4.6	16.5	38.0
After 2 weeks	1.2	5.3	23.3	39.4
After 3 weeks	2.0	6.3	25.6	44.0

[fol. 451] Unless unfavorable weather conditions prevail, a delay of several days is not serious under a system of careful handling which insures the packing of the fruit in sound condition, but it is far better to avoid delay as much as possible, even if the attendant conditions are most favorable.

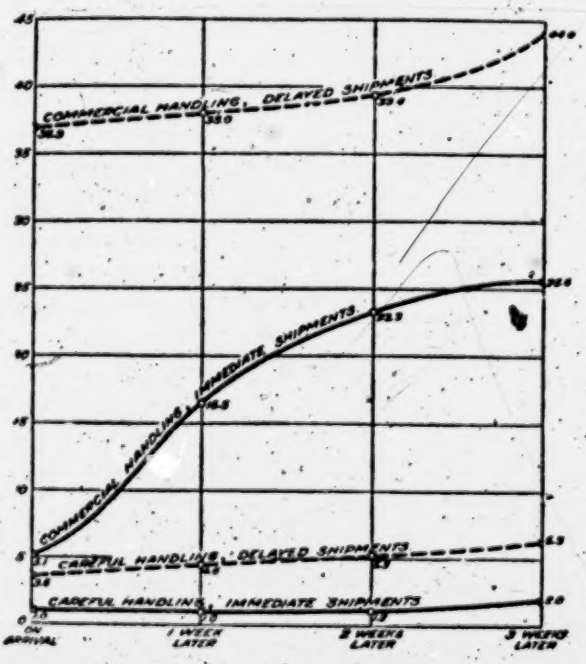


Fig. 19.—Diagram illustrating the percentage of blue-mold decay of oranges in immediate and delayed shipments from one house, on arrival in Washington and after holding for three weeks during a period of high decay, December, 1911.

Comparison of the Work of Different Packing Houses.

Typical rough and careful handling.—The figures presented in Tables XVII to XX and the accompanying diagrams include the averages of both commercial and experimental shipments from a number of houses representing all classes of work. Extremes of rough handling and consequent very high decay during transit, as well as extremes of careful handling accompanied by excellent shipping quality, were found in different parts of the State.

Table XVII and its accompanying diagram (fig. 20) give the average percentages of decay occurring during 1910-11 and 1911-12 in the commercial shipments from 12 houses using care and from a like number of houses in which the work was roughly done. During both seasons the percentage of decay in the commercial fruit shipped by the houses using care was almost as low as the average for any of the carefully handled lots, picked, graded, and packed by bureau workers. The practicability of conducting commercial operations with sufficient care to eliminate decay is thus plainly demonstrated. The results of the two series of shipments present a striking and consistent contrast throughout both seasons. The averages of the carelessly handled commercial lots were somewhat lower during 1911-12 than they were in 1910-11, but the proportion of decayed fruit on arrival (10.9 per cent) is still too high for good commercial result.

Table XVII.—Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in shipments showing high and low blue-mold decay in careful and in commercial pack, 1910-11 and 1911-12.

Year	Inspection	12 shipments showing low decay		12 shipments showing high decay	
		Careful	Commercial	Careful	Commercial
		Per cent	Per cent	Per cent	Per cent
1910-11	On arrival	0.1	0.4	0.4	14.6
	After 1 week	.2	.8	.8	22.2
	After 2 weeks	.2	1.3	1.5	27.8
	After 3 weeks	.3	1.6	2.1	30.8
1911-12—	On arrival	.1	.6	1.1	10.9
	After 1 week	.3	1.7	1.3	16.1
	After 2 weeks	.6	3.0	1.7	20.5
	After 3 weeks	1.2	4.4	2.7	25.9

[fol. 452] Table XVIII and figure 21 give the average percentages of decay or oranges from two packing houses in the same locality working on practically the same kind of fruit. The type of work in house No. 1 was good, but that in house No. 2 was rather poor. These shipments were made at the same time, and the results of carefully handled lots prepared by the bureau workers from the same houses are given for comparison.

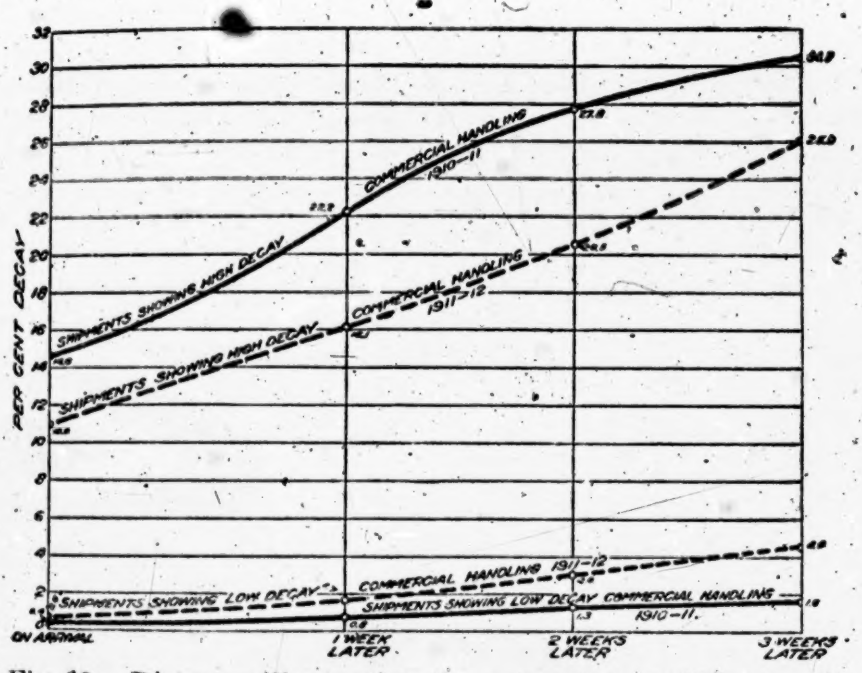


Fig. 20.—Diagram illustrating the percentages of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in shipments showing high compared with low decay in commercial pack, 1910-11 and 1911-12.

Table XVIII.—Blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots shipped from two houses in the same locality, 1910-11.

Time of examination	House No. 1		House No. 2	
	Careful	Commercial	Careful	Commercial
	Per cent	Per cent	Per cent	Per cent
On arrival	0.4	2.4	0.3	21.3
After 1 week	1.5	4.5	.3	28.9
After 2 weeks	1.8	5.7	.3	48.2
After 3 weeks	2.5	5.7	.7	59.5

It will be noticed that the commercial shipment from house No. 1 gave practically as favorable returns as the specially prepared shipments of the bureau workers, the difference being only 2 per cent, both series from this house having less than the commercial allowance of 3 per cent decay on arrival. The commercial shipments from house No. 2, where observation showed the handling to be rather careless, had developed 21.3 per cent of decay on arrival at Washington; while the fruit handled by the bureau workers at the same time and shipped under identical conditions showed 0.3 per cent of decay. After three weeks the commercial shipments from house No. 1 averaged 5.7 per cent of decay, and those from house No. 2 showed 59.5 per cent, as against 2.5 per cent and 0.7 per cent, respectively, for the carefully handled fruit.

[fol. 453] Relation of Character of Picking to Decay.—A study of field handling in connection with the occurrence of decay in commercial shipments was made in two packing houses in Florida during 1911-12. It would be hard to find

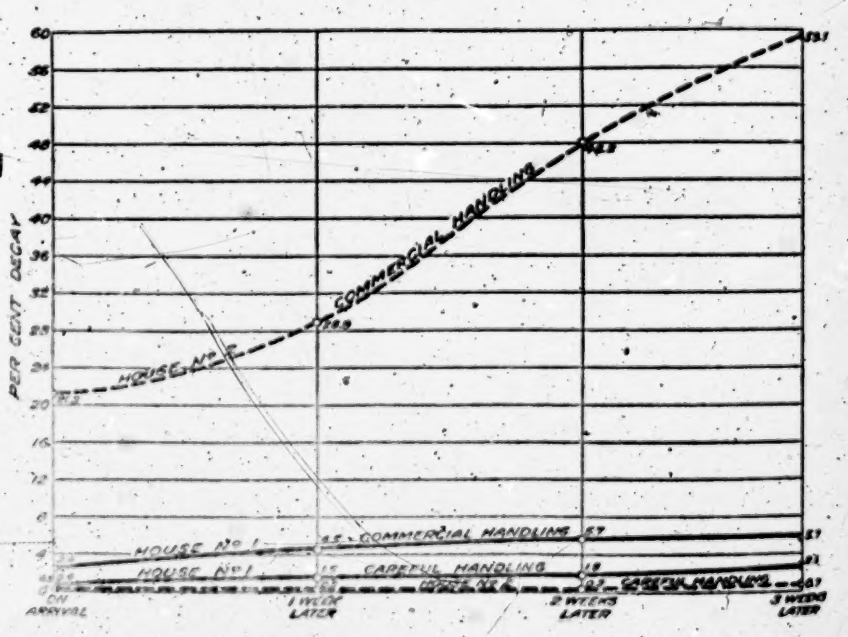


Fig. 21.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in carefully handled and commercially handled lots shipped from two houses in the same locality, 1910-11.

a more striking illustration of the effects of careless handling than that presented in Table XIX and in the diagram (fig. 22). It should be borne in mind that all of these results were obtained from lots of commercially handled fruit, no attempt being made by the bureau workers to influence the type of handling. They merely inspected the field work and made sure that the boxes selected for experimental shipment were representative.

In house No. 1, where the type of handling was fairly good, the proportion of clipper cuts was 0.2 per cent; of pulled fruit, 1.6 per cent; and of long stems, 4 per cent. The immediate shipments of this fruit showed no decay on arrival, while the delayed lots had 3.7 per cent. After holding three weeks in market, 6 per cent and 8.2 per cent of decay developed in the immediate and delayed shipments, respectively.

Table XIX.—Imperfections in Picking and the Percentage of Blue-Mold Decay of Commercially Handled Oranges on Arrival in Washington and After Holding for Three Weeks, from Two Houses in the Same Locality, 1911-12, Showing the Effect of Careful Handling on the Carrying Quality of Fruit.

Class of imperfections	Picking inspections	
	House No. 1	House No. 2
	Per cent	Per cent
Clipper cuts	6 2	7 4
Long stems	4 0	56 8
Pulled	1 6	1

[fol. 454] Table XIX.—Imperfections in picking and the percentage of blue-mold decay of commercially handled oranges on arrival in Washington, etc.

Time of examination	Experimental shipments			
	House No. 1		House No. 2	
	Immediate	Delayed	Immediate	Delayed
	Per cent	Per cent	Per cent	Per cent
On arrival	0	3 7	8 0	19 4
After 1 week	1 5	5 2	12 0	23 0
After 2 weeks	2 7	6 7	15 6	27 4
After 3 weeks	6 0	8 2	22 4	34 5

In house No. 2, which was selected for rough handling, the percentage of clipper-cuts was 7.4 per cent; of pulled fruit, 0.1 per cent.; and of long stems, 56.8 per cent. The immediate shipments from this house showed an average of 8 per cent decay on arrival and the delayed shipments 19.4 per cent, these percentages being increased to 22.4 and 34.5, respectively, after three weeks in Washington.

The relationship between the type of field handling and the behavior of the fruit while in transit has been definitely established by numerous experiments during several seasons. The experiment cited above fairly represents the general character and results.

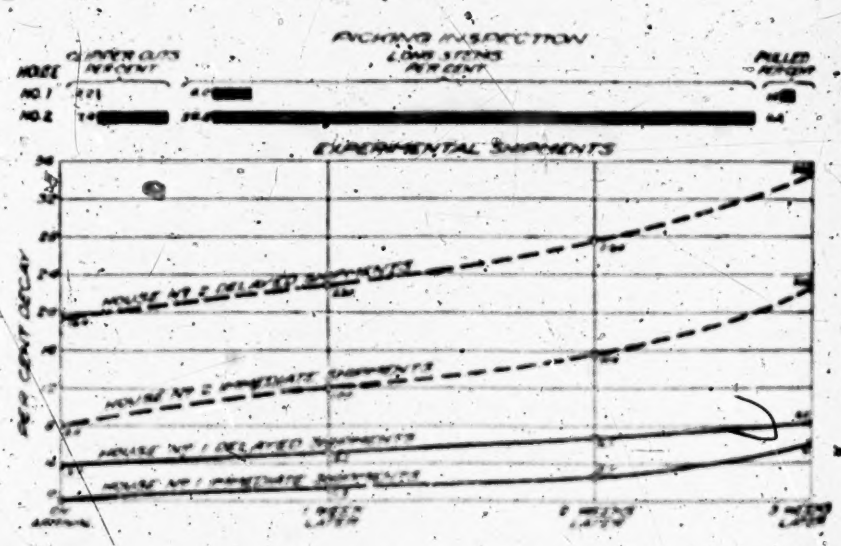


Fig. 22.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in commercially handled lots from two houses in the same locality, 1911-12, showing the effect of careful handling on the carrying quality of the fruit.

The figures presented in Table XX and the accompanying diagrams (figs. 23 and 24) are shown to indicate the practicability of improving the handling and shipping conditions by giving special attention to the organization of the labor forces. The packing house from which the data were obtained was reorganized at the end of the 1910-11 season; the machinery was simplified and every effort was directed toward the introduction of better handling methods. Two

experimental shipments were made—one during 1910-11 and one during 1911-12, two lots being sent out each season. The results of the inspections of the field work are given to show the great improvement in the second season, the results of careful handling by the bureau workers being also included for comparison with the commercial work done during the two seasons.

[fol. 455] Table XX.—Imperfections in Picking and the Percentage of Blue-mold Decay of Fruit on Arrival in Washington and After Holding for Three Weeks, Shipped from one Packing House During 1910-11 and 1911-12, Showing Decrease in Blue-Mold Decay Due to Greater Care in Handling

	Picking inspections		
	1910-11		
Class of imperfections	Jan. 17	Mar. 3	1911-12 Dec. 13
	Per cent	Per cent	Per cent
Clipper cuts	11 3	5 7	1 8
Long stems	23 0	11 9	10 4
Pulled	1 0	5 1	1 4

	Experimental shipments			
	1910-11[1]		1911-12[2]	
Time of examination	Careful	Commercial	Careful	Commercial
	Per cent	Per cent	Per cent	Per cent
On arrival	0 2	8 0	0 3	1 1
After 1 week	6	12 6	9	2 4
After 2 weeks	8	15 3	1 2	2 8
After 3 weeks	1 3	15 8	1 5	4 1

It will be noticed that in 1910-11 (fig. 23) the total imperfections in the field handling amounted to 35.3 per cent at the first inspection and 22.7 per cent at the second. The average percentage of decay in the commercial shipments was 8 per cent on arrival at Washington, the carefully handled lots developing 0.2 per cent. In 1911-12 (fig. 24) the field work, while far from perfect, was considerably improved, the inspections showing 13.6 per cent of imper-

[1] Fruit picked Feb. 1, 1911.
[2] Fruit picked Dec. 13, 1911.

fections. The commercially handled fruit showed 1.1 per cent of decay on arrival, and the lots prepared by the bureau workers had 0.3 per cent. After holding the fruit in Washington for three weeks the commercially handled oranges developed 15.8 per cent of decay during 1910-11 and 4.1 per cent during 1911-12. When it is considered that the variation in the percentage of decay for these two seasons

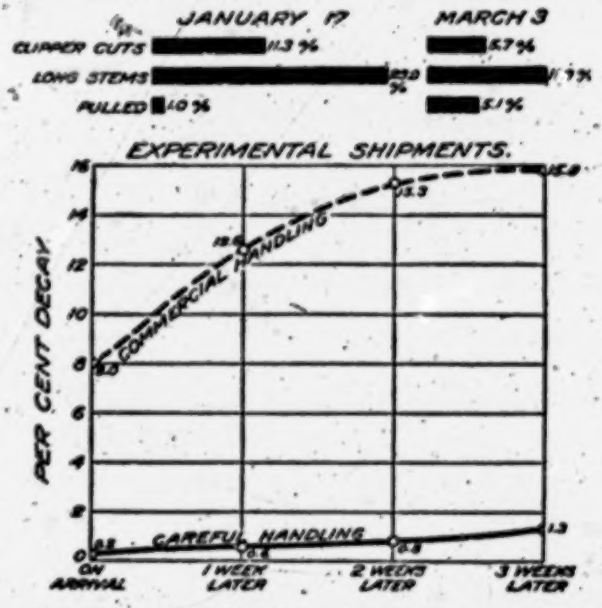


Fig. 23.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in fruit shipped from one packing house, showing decrease in blue-mold decay due to greater care in handling, 1910-11

may easily mean a difference between profit and loss in the sale of the fruit from this house, the data presented become particularly impressive. It would be difficult to assemble a stronger array of facts than those brought together in this figure to illustrate the fundamental importance of preserving the sound carrying quality of oranges. The significance of the connection between field handling and the occurrence of decay during transit is definitely shown, as well as the practicability of improving conditions by means of more systematic management. This presentation should be sufficient to convince even the most skeptical that loss from decay in the shipment of Florida oranges is dependent

upon the character of handling given the fruit in field and packing house.

[fol. 456] Results From a Financial Standpoint

In order to emphasize the importance of careful work, the data may be analyzed from a financial standpoint. The results are perhaps more impressive when expressed in dollars and cents than when a statement is made regarding the percentages of decay in various lots of fruit.

The difference between the average percentages developed in the carefully picked and packed and the commercially picked and packed fruit during the season of 1910-11 was 6.4 per cent. This means, that 1 out of approximately every 15½ boxes shipped during the season was unnecessarily destroyed by blue-mold decay, and that this loss might have been avoided if the fruit had been handled with care approximating that given by the bureau workers. It is only necessary to extend this line of reasoning. Out of every 100 boxes of fruit shipped, the avoidable loss was 6½ boxes; therefore, on a basis of 3,500,000 boxes of oranges shipped from Florida during the season of 1910-11 this loss aggregated 224,000 boxes, which at a fair f. o. b. price of $1.50 per box gives a direct money loss of $336,000.

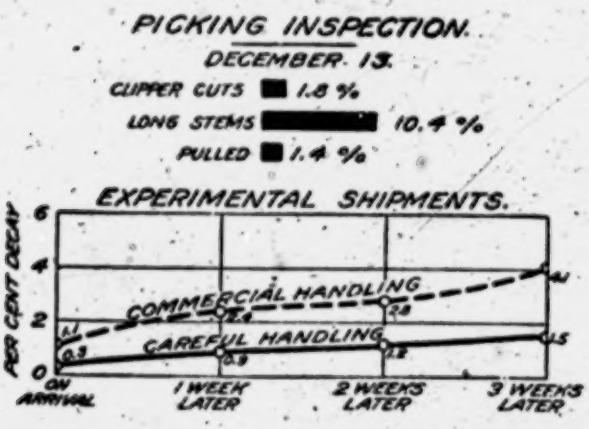


FIG. 24.—Diagram illustrating the percentage of imperfections in picking and the percentage of blue-mold decay of oranges on arrival in Washington and after holding for three weeks, in fruit shipped from one packing house, showing decrease in blue-mold decay due to greater care in handling, 1911-12

In 1911-12 the difference in decay between the carefully handled and commercially handled fruit was 3.5 per cent, or a loss of 1 box for every 28½ boxes shipped. A fair estimate of the total shipment of oranges during that season is 3,750,000 boxes. The loss on this fruit, at the rate indicated, aggregates 131,250 boxes, which, figured at prevailing prices, may be valued at approximately $200,000. Perhaps this is an exaggerated method of analyzing the true condition of affairs, yet when one takes into consideration the immense financial outlay necessary to pick, haul, grade, and pack these oranges, the actual money loss is not far from the amounts stated.

The figures stated above approximate the net loss to the growers due to decay. In addition, there is a large loss due to the cost of transporting and selling. According to statistics recently compiled, it costs from $1.75 to $1.93 to produce, prepare for shipment, and deliver in market one packed box of oranges.[1] With this cost as a basis, the losses reached the stupendous totals of $432,320 during 1910-11 and approximately $250,000 during 1911-12.

From the standpoint of the effect upon the reputation of the Florida product the financial loss is even greater. It is impossible to give such a loss in actual figures, for the value of a reputation for high shipping and holding quality can not be estimated in dollars and cents. It is safe to say that the introduction of more careful methods would not increase the cost of handling to any material extent. No figures are available for such an increase, but the extra expense would certainly be only a small fraction of the actual money loss enumerated above. Leaving out of consideration the desirability of a good reputation, these figures should serve to convince those people who can appreciate values only from a financial standpoint that careful handling is necessary for the success of the industry.

[fol. 457] Seasonal Influences on the Occurrence of Decay

It has been the general experience that blue-mold decay is more prevalent in Florida during the early months of the shipping season than it is later. Losses are most severe

[1] Statements of J. C. Chase and W. C. Temple before the Committee on Ways and Means, U. S. House of Representatives, 1913.

in December and January, the former month as a rule having the highest percentage of decay. So characteristic has this early deterioration been in the past that growers have become convinced that the underlying causes are not confined to improper methods of handling, and that the loss is due to some disease other than blue mold. Careful observation on the part of the bureau workers has shown this impression to be incorrect. An analysis of the circumstances under which fruit is handled during December shows that at that time of the year the conditions for the development of blue mold are particularly favorable. Rains are more or less prevalent and the humidity is generally high. It follows, therefore, that the type of handling which might suffice under favorable weather conditions will not then prove satisfactory.

In addition to bad weather conditions, the character of work done during the early part of the season is undoubtedly less careful than what is practiced later on. Shippers are in a hurry to get their fruit on the market in time for the holiday trade, and most of the workmen have not had sufficient experience. It seems impracticable, in Florida at least, to hold field and packing-house labor together throughout the year and to maintain a permanent organization. New pickers must therefore be trained each season, the same being true in the case of the packing-house labor, although probably to a less extent. These factors tend to lower the standard of early handling operations.

All the experiments made by the Bureau of Plant Industry emphasize the importance of systematic organization of the labor forces and careful handling of the fruit in every stage of its preparation for shipment. Every effort should be directed toward maintaining the fruit in sound condition from the time it is picked until it is unloaded as its final destination and placed in the hands of the consumer. During unfavorable seasons, frequent thorough inspections of the various operations through which the fruit passes are most essential. Instead of lowering the standard at this time, it is extremely important to approach the ideal as closely as possible.

In Tables XXI and XXII and figures 25 and 26, the percentage of decay occurring during the months of December, January, and February in 1910-11 and 1911-12 are presented. Table XXI and figure 25 shows the decay in the

carefully handled and commercially handled experimental shipments on arrival in Washington during December, January, February, and March, for both seasons. During December, 1910, the average percentage of decay in commercial shipments, on arrival at Washington, was 13.9 per cent. During December, 1911, the corresponding lots showed 9.4 per cent on arrival. The careful shipments during these months had 2.3 per cent in 1910 and 1.3 per cent in 1911, respectively.

Table XXI—Blue-mold Decay of Oranges on Arrival in Washington and After Holding for Three Weeks, by Months, in 1910-11 and 1911-12

	Careful pick and pack		Commercial pick and pack	
Time of examination	1910-11[1]	1911-12[2]	1910-11[1]	1911-12[2]
On arrival:				
	Per ct.	Per ct.	Per ct.	Per ct.
December	2.3	1.3	13.9	9.4
January	.5	.6	6.8	4.0
February	.5	.2	6.2	1.6
March	.3		5.0	
After 1 week:				
December	3.4	1.7	19.1	12.2
January	1.1	.9	11.4	6.8
February	.9	.4	10.2	4.5
March	.6		7.3	
After 2 weeks:				
December	4.3	2.1	21.6	15.1
January	1.6	1.4	14.5	10.1
February	1.4	1.0	12.4	9.6
March	1.0		8.5	
After 3 weeks:				
December	4.4	2.8	22.2	17.2
January	1.9	2.2	15.8	13.5
February	1.7	2.0	13.3	14.2
March	1.2		9.6	

[1] The figures for 1919-11 include 7 comparable shipments for December, 28 for January, 28 for February, and 16 for March.

[2] The figures for 1911-12 include 8 comparable shipments for December, 39 for January, and 18 for February.

[fol. 458] Averaging the results for December, 1910 and 1911, the commercially handled fruit showed 11.6 per cent of decay on arrival and the carefully handled 1.8 per cent. During the months of January, 1911 and 1912, the decay of oranges shipped under commercial conditions was 6.8 per cent and 4 per cent, respectively. The corresponding carefully handled fruit showed 0.6 and 0.5 per cent, respectively, or practically the same for both years.

During February commercially handled fruit showed 6.2 per cent of deterioration on arrival at Washington in 1911, the percentage of decay for the following year being 1.6 per cent. The average of the February lots for the two seasons was 3.9 per cent. Carefully handled fruit during 1911 and 1912 arrived with 0.5 and 0.2 per cent of decay, respectively, the average for the two years being 0.3 per cent.

No experimental shipments were made later than February during the second season. In March, 1911, the average percentage of decay in commercial shipments was 5 per

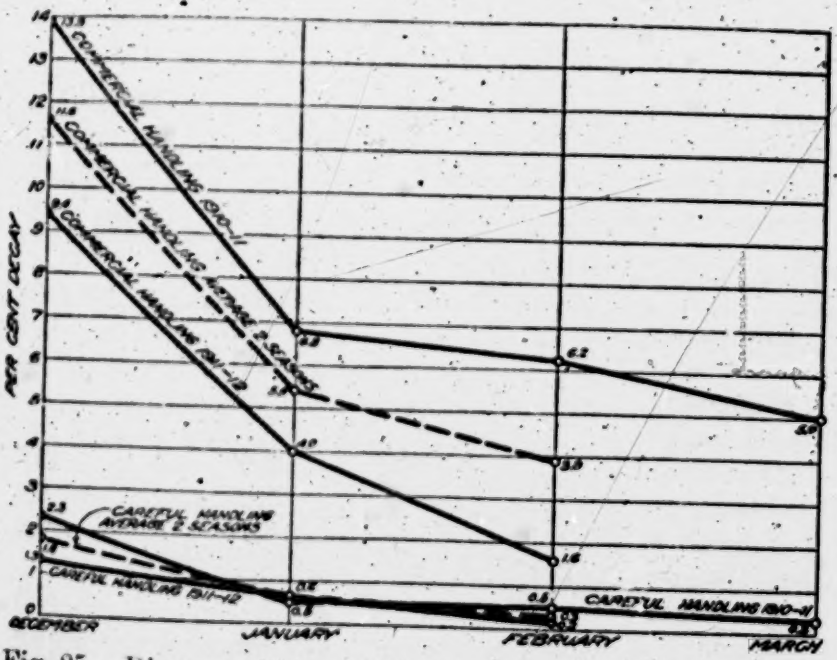


Fig. 25.—Diagram illustrating the percentage of blue-mold decay of oranges on arrival, by months, during two seasons, 1910-11 and 1911-12.

cent on arrival, the carefully handled lots showing only 0.3 per cent.

These figures are significant in that they show a very high percentage of decay during December, followed by a gradual decrease as the season advances. This is true for both commercially and carefully handled fruit, although in the case of the latter the loss was, without exception, below the usual 3 per cent commercial allowance. It is scarcely probable that decay can be held below this point even with the best system of handling, for it is practically impossible to eliminate every injured orange or to carry on the handling operations in such a way that absolutely no injury is done. The general principal that very slight injury will result in decay when weather conditions are favorable for the development of blue mold is substantiated by these figures, and the importance of extra care during the early months is again emphasized.

[fol. 459] Table XXII and figure 26 show the average percentages of decay found in fruits shipped during December, January, and February, 1910-11 and 1911-12, on arrival at Washington and after holding for three weeks under ordinary market conditions.

Table XXII.—Blue-mold decay of oranges on arrival in Washington and after holding for three weeks; average of the two seasons, by months, in 1910-11 and 1911-12.

Time of examination.	Careful pick and pack.	Commercial pick and pack
On arrival:		
	Per cent	Per cent
December	1.8	11.6
January	.6	5.4
February	.3	3.9
After 1 week:		
December	2.5	15.7
January	1.0	9.1
February	.7	7.3
After 2 weeks:		
December	3.2	17.8
January	1.5	12.8
February	1.2	10.5
After 3 weeks:		
December	3.6	19.7
January	2.1	14.6
February	1.8	13.8

The commercially handled fruit, picked and shipped during December, showed the highest average percentage of decay on arrival (11.6 per cent), and the increase after three weeks was correspondingly higher than was the case for fruit picked and shipped during January and February. Commercially handled fruit, picked and shipped during January, arrived with 5.4 per cent of decay, and that sent

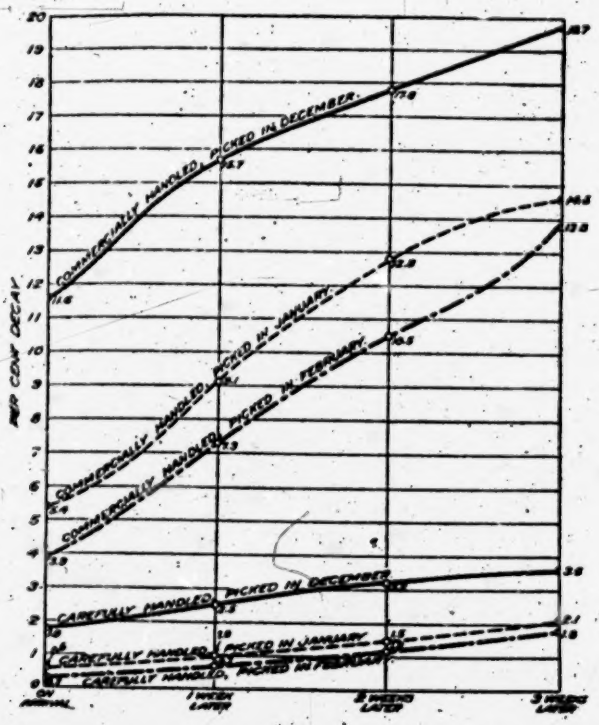


Fig. 26.—Diagram illustrating the percentage of blue-mold decay in carefully handled and commercially handled oranges picked during December, January, and February; average of the two seasons, 1910-11 and 1911-12.

out during February showed 3.9 per cent on arrival. The shipments of carefully handled fruit arrived with an average of 1.8 per cent during December, 0.6 per cent during January, and 0.3 per cent during February, and after holding for three weeks showed 3.6 per cent, 2.1 per cent, and 1.8 per cent of decay, respectively. All of the carefully handled fruit, even that shipped during December, showed much less decay after three weeks in market than the commercial shipments during February showed on arrival. The

superior shipping and market-holding qualities of carefully handled fruit are evident.

Precooling

The term "precooling" has been used to designate the prompt and rapid cooling of fruit prior to shipment. The initial cooling of the product is accomplished very slowly when the fruit is shipped under ordinary icing conditions, the ice of a refrigerator car not being able to cool the fruit with sufficient promptness and rapidity to prevent the de- [fol. 460] velopment of decay. Consequently, deterioration is often far advanced before the temperature of the fruit is reduced to the point where these processes are checked. Under a system of precooling, the ice of the refrigerator car is relieved of the burden of initial cooling and is merely required to keep the fruit cool during transit.

Precooling is accomplished by means of special equipment, the refrigerating medium being either ice and salt or special refrigerating machinery. When adequate equipment is supplied, the initial temperature of the fruit may be reduced in a comparatively short time. The work may be done in refrigerated rooms or chambers before the boxes are placed in the cars, or it may be accomplished by circulating cold air around the packages after loading. The comparative advantages and limitations of these two systems can not be discussed here, but a few important points regarding the application of precooling to the shipment of Florida oranges must be emphasized.

Precooling may not safely be depended upon to offset decay following mechanical injuries due to improper methods of handling the fruit when preparing it for shipment. It is, however, a valuable and legitimate means of insuring arrival on the market in sound condition after each grower, packer, and shipper has done his share in properly handling the fruit. Precooling, in order to be effective, must be accomplished promptly and rapidly. A considerable delay in applying the process may nullify all possible benefits and defeat the object for which the work is undertaken.

Icing has been practiced to a limited extent in Florida, but precooling has not as yet been attempted. The value of this method of shipment in marketing Florida oranges

is largely problematical. Its advantages are likely to be overestimated if the general distribution and application of the processes are attempted without careful and systematic investigation. During the warm and humid weather usually prevalent in Florida in December and January, precooling may be of considerable benefit, provided always that it is not expected to offset the bad effects of careless or improper handling. During warm and humid weather, such as occurred during the months of December, January, and part of February of the season of 1912-13, oranges are injured more easily than under ordinary conditions and are more subject to decay from these injuries. Infection from the ever-present, blue-mold spores is almost certain, and stem-end decay or other diseases may gain considerable headway. Rapid cooling (precooling) may possibly delay the development of stem-end decay for a week or more after the fruit arrives in market. While precooling and refrigeration can not do more than to delay for a short time the occurrence and development of this disease, such delay may prove of material benefit.

Precooling may reduce the quantity of ice consumed during the trip to market by removing the necessity of cooling fruit at the beginning of the trip. Possibly during the winter season, when the weather is cool or cold along the route, fruit which has been precooled may be moved to its destination under the initial icing alone. Precooling is expensive, and unless a material advantage can be obtained thereby its application can not be justified. If a sum of money equal to the expense of precooling is expended in insuring careful handling of the fruit during the course of its preparation for shipment, the returns will probably be more certain and more lasting.

Stem-end Rot

In addition to the losses from blue mold, there has been considerable deterioration of Florida citrus fruits after arrival in market due to the attacks of the stem-end decay fungus. Unlike blue mold, this fungus does not apparently depend upon injuries or breaks in the skin through which to gain entrance to the tissues of the fruit. Investigation during the season of 1910-11, in cooperation with the Florida experiment station, proved conclusively that the stem-end

rot disease can not be controlled by means of careful han-
[fol. 461]-dling. The results of this investigation into the nature of the fungus, its manner of growth, and its develop-ment have been published by the Florida experiment sta-tion.[1]

Summary

The orange crop of Florida averages 4,000,000 or 5,000,000 boxes per year, and it has been estimated that, balancing the good with the bad years, probably 10 per cent of the fruit decays before reaching the consumer. This entails an annual financial loss of at least half a million dollars. By far the most common form of decay is that caused by the growth of the blue mold fungus within the tissues of the fruit, entrance being obtained only through some mechanical injury to the skin. The first operations of the Bureau of Plant Industry indicated that, owing to improper equipment in groves and packing houses as well as to the carelessness of pickers and packers and their ignorance of the essential factors of good handling, much preventable injury was being inflicted on the fruit in the course of its prepa-ration for shipment. Most serious of all was the injury inflicted by the clippers in severing the fruit from the tree and the punctures caused by the prongs of long stems in the oranges. Many lesions or abrasions especially those caused by dropping the fruit, can not be detected by packers and develop heavy decay in transit.

In most sections of the State shipping the fruit as soon as ripe is a necessity, owing to the wide distribution of the citrus white fly and the development of the sooty mold fungus which follows in the wake of that pest. To prevent probably 75 per cent of the Florida orange crop is ruined either by washing or by the cavalier method. The Department investigations show that decay in transit or on the market is largely due to injuries received or aggravated during washing and drying and that these operations may be conducted in such a way that little or no harm ensues or may be followed by serious deterioration. The experiments of the Bureau of Plant Industry during the past seven years prove conclusively that the condition of the

---

[1] Fawcett, H. S. Stem end rot of citrus fruits. Florida Agricultural Experiment Station, Bulletin 106.

fruit after arrival in market depends largely upon the character of the work done in the grove and the packing house; that it is possible to so conduct the operations of picking, packing, and shipping as to inflict a minimum of mechanical injuries; and that unirrigated Florida oranges can be placed on the market in practically sound condition even in seasons of very high decay. Practically all loss from blue mold decay, such as has occurred in the past, can be eliminated.

The sizes of Florida oranges vary from 80 to 420 fruits in a box, the most common sizes being 126, 150, 176, and 200 to a box. The Florida shipping box measures 12 by 12 by 24 inches, inside dimensions, and has an estimated weight of 80 pounds when filled. The average shipment put out totals 324 boxes, loaded 7 tiers high. A standard shipping car is 33 feet long, 8 feet wide, and 8½ inches high; the minimum freight weight of a standard car of 300 boxes is 24,000 pounds. The average freight rate on citrus fruits from Florida during 1912-13 was 62.7 cents per box of 80 pounds weight.

During the past five years the Florida citrus industry has been reorganized and the changes have greatly improved the handling of the fruit. At the time the Department investigations were begun the methods of preparing oranges for shipment were extremely crude; there was no uniformity of system and the equipment was wholly inadequate to the needs of the industry. Of late years the old type of packing house has almost entirely disappeared. Modern houses, equipped with the newest machinery for handling fruit properly, have been constructed in practically every citrus district in the State, so that the industry is now well provided with the mechanical appliances for doing good work. Further reforms will include improvement of field equipment and more careful attention to the details of picking and to the organization of the picking and packing crews. The men should be paid by the day instead of by the box, and a responsible foreman should carefully oversee the work of the individual pickers. The Inman experiments prove that it is possible to train workmen to use more care and to greatly reduce their percentage of imperfections.

More than 90 experimental shipments of oranges were made from Florida in 1910-11, and 65 were sent out in 1911-

12, including fruit from every section of the State and from good, poor, and average houses. Plate XV illustrates the condition in which some of these lots arrived in Washington. The carefully picked, graded, and packed fruit showed 4 per cent of decay on arrival, the commerically picked but carefully graded and packed fruit showed 35.6 per cent, and the commercially handled fruit had 65.9 per cent. After one week these percentages had increased to 4 per cent, 46 per cent, and 71.6 per cent, respectively; after two weeks they were 11.5 per cent, 54 per cent, and 72.2 per cent; and after three weeks, 11.5 per cent, 57.1 per cent, and 72.2 per cent.

The carefully handled fruit arrived in Washington during both seasons with less than 1 per cent of decay, or an average for the two years of 0.6 per cent for all the experimental shipments. The fruit handled under commercial conditions throughout had developed more than twice as much decay by the first inspection as occurred in the carefully handled fruit at the end of three weeks.

That commercial handling may also be careful handling is demonstrated by the fact that during both seasons the average percentage of decay in the commercial fruit shipped from 12 houses using care was almost as low as the average for any of the lots carefully handled by the bureau workers. In one packing-house, where during 1910-11 the percentage of decay in the commercially handled fruit reached 15.8 per cent after holding for three weeks in Washington, the handling operations were so improved by the adoption of the bureau methods that during 1911-12 only 4.1 per cent of decay developed in the commercially handled fruit at the end of the same period.

It has been the general experience that blue-mold decay is more prevalent in Florida during the early months of the shipping season than it is later. All of the fruit carefully handled by the bureau workers, even that shipped during December, showed much less decay after three weeks in market than the commercial shipments during February showed on arrival. The shipping experiments showed that carefully handled fruit may be "cured" without serious loss, but that whenever the fruit has been appreciably damaged in the course of its preparation for shipment, decay is materially greater in the delayed lots.

Although not more than 1 per cent of the total shipments of citrus fruits had previously been iced, during 1912-13 a considerable number of commercial shipments were sent north under refrigeration. No systematic study was made of the behavior of fruit of the same grade and quality under the two systems of shipment, but the general opinion seems to prevail among shippers that the icing resulted in material benefit to the fruit. The investigations of the Bureau of Plant Industry have demonstrated, however, that Florida oranges may be transported to market under ventilation with a minimum loss from decay, even during periods of warm and humid weather, if sufficient care is used to preserve the skin of the fruit in an unbroken condition.

Conclusions

In the light of the principles established by the workers of the Department of Agriculture in the investigations and experiments of the past seven seasons, viz., that the condition of the fruit after arrival in market depends largely upon the character of the work done in grove and packing house, and that it is possible to so conduct the operations of picking, packing, and shipping as to inflict a mimimum [fol. 463] of mechanical injuries from which decay may develop, the following points are recommended to the attention of growers and shippers of Florida citrus fruits:

Workmen, especially pickers, should be paid by the day and not by the quantity of work done.

More careful attention to the details of picking and to the organization and inspection of the picking crews is necessary. Each member of the crew should be held responsible for the character of his work. An efficient field foreman should supervise the pickers, watch their output, and insist on careful handling. He should be prohibited from picking fruit himself.

Clippers with rounded or blunted points should be supplied. These should be frequently inspected by the foreman to prevent their becoming dull or loose at the joint.

Picking sacks of heavy material, which have partially closed mouths, allowing the fruit to be emptied from the bottom, and having a capacity of not more than half of a large standard field box, should be used.

Pickers should not pull the fruit from the tree. All oranges should be severed by means of the "double cut."

Fruit should be placed carefully in the picking sack and not dropped nor tossed in.

The picking sack should be lowered into the field box and the oranges allowed to roll out gently without appreciable drop.

No fruit should be picked up from the ground and placed in the field boxes.

Smaller field boxes of lighter materials are recommended.

The fruit should not project above the top of the field box, and the latter should be transported to the packing house on a spring wagon. The driver should be given an especially prepared seat and not allowed to sit on the fruit.

Each picker and packer should be required to wear gloves.

Picking receptacles, field boxes, and packing bins should be kept free of gravel, twigs, splinters, protruding nails, or other foreign matter.

The efficiency of the packing house may be spoiled by a desire to save floor space. Simplicity should govern the choice and disposal of all equipment.

The desirable hopper is small, has padded sides, and allows the fruit to be emptied gradually by means of moving belts. The fruit should not fall by gravity at any stage of its journey.

Uniform and definite grading rules should be established for the State.

Wherever washing is not absolutely necessary in order to render the fruit marketable it should be omitted.

Water in the soaking tank should be frequently changed, and sprays of fresh water should be directed against the fruit as it passes through the washing machine.

The best type of washing machine has the fruit in plain sight at all times, allows no pressure on the oranges save that afforded by their own weight, does not allow the fruits to tumble over or against each other, and does not allow twigs, thorns, nails, etc., to become lodged in the runway through which the fruit must pass.

Fruit should never be packed while moist. An artificial drier in which a warm air blast is circulated around the fruit seems to be a necessity from the standpoint of thorough work and careful handling

The sawdust method of cleaning grapefruit is ineffective as well as highly injurious.

Loose packs of fruit are more liable to be injured in transit than those of medium height with every orange firmly in place.

Decayed fruit should not be left in the boxes or allowed to accumulate on the floor or under the packing bins in the packing houses.

Curing is unwise, as the delay increases the chance for the infection of bruises or injured spots and facilitates the development of decay before shipment and in transit.

[fol. 464] During unfavorable weather, especially during December and January, when warm and humid weather is prevalent in Florida, frequent thorough inspections of the various operations through which the fruit passes are most essential. Instead of lowering the standard at this time, it is extremely important to approach the ideal as closely as possible.

Precooling may not safely be depended upon to offset decay following mechanical injuries due to improper methods of handling the fruit when preparing it for shipment, but it is a valuable and legitimate means of insuring arrival on the market in sound condition after each grower, packer, and shipper has done his share in properly handling the fruit.

[fol. 465] PLAINTIFFS' EXHIBIT No. 25

Government of Porto Rico Board of Commissioners of Agriculture, Insular Experiment Station, Rio Piedras, P. R.

Bulletin No. 7

The Handling of Porto Rican Oranges, Grapefruit, and Pineapples

By C. W. Mann, Pomologist, Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, United States Department of Agriculture

San Juan, P. R.

Bureau of Supplies, Printing, and Transportation, 1914

apples has increased very materially during the last five

years as is shown by Table V, which gives the imports at New York. The freight rate on pineapples from Porto Rico to New York varies from 30 to 35 cents per crate.

Table V.—Number of Crates of Pineapples Exported from Porto Rico to New York, 1908-1913, Inclusive [1]

	1908	1909	1910	1911	1912	1913
Pineapples	74,000	186,000	283,500	342,500	353,283	364,828

Decay of Porto Rican Citrus Fruit

During the past ten years the Bureau of Plant Industry of the Department of Agriculture has been engaged in a study of the principles underlying the successful handling [fo]. 466] and shipment of citrus and deciduous fruits. In the investigations of the decay of citrus fruits in California and Florida and more recently of pineapples in Florida, it has been found that a close relation exists between the occurrence of decay and the character of the methods employed in picking, packing and transporting the fruit. The reader is referred to the published reports of the Bureau of Plant Industry [2] for a discussion of the proper and improper methods of handling the fruit and their effect upon the occurrence of decay.

The organization of the Porto Rican Fruit Exchange in 1910 has had a very good effect on the industry. This association has done much to improve the methods of handling the fruit and to organize the marketing on a sound basis.

The decay which develops in Porto Rican citrus fruits while in transit is commonly of two kinds. One form of rot is the blue mold, caused by the growth within the tissues of the fruit of a fungus of the genus *Penicillium;* the other is a stem-end rot caused by a fungus of the genus *Diplodia.*

---

[1] These figures were furnished by the New York office of the New York Fruit Exchange.

[2] The Decay of Oranges while in Transit from California. Bureau of Plant Industry Bulletin 123.

Factors Governing the Successful Shipment of Oranges from Florida. U. S. Department of Agriculture, Bulletin 63.

A short discussion of the general nature of fungi may be of interest here.

The class of fungi includes all those plants of very low organization which multiply their kind by cell-division or by spores and which are popularly known as mushrooms or toadstools, puffballs, rust, molds, mildews, yeasts, etc. The part which is exposed to view is merely the fruit-bearing portion of the plant. The vegetative part which supplies material for the growth of the plant and which corresponds to the roots and leaves of higher plants is hidden away in the organic matter upon which the fungus feeds. Both the vegetative and fruiting parts of all the fungi are made up entirely of microscopic threads which are very much branched and divided into elongated cells. These threads are called hyphæ and the vegetative hyphæ [fol. 467] are collectively spoken of as the mycelium of the fungus. In the lower fungi such as molds, the mycelium is comparatively simple, consisting of much-branched threads which course through the material upon which they grow. At the time of fruiting many threads grow out to the light and air and finally bear spores at the ends. The fungus is spread by means of these spores, which require heat and moisture in order to develop and which germinate and grow as soon as they find lodgement under favorable conditions. For convenience fungi may be divided into two general classes—those which can and those which cannot penetrate the sound, healthy skin of an orange or other fruit. The control of fungi of the first class depends upon the improvement of the conditions under which the fruit is produced and upon the condition of the soil and health of the tree. The second class may be controlled by so improving the methods of handling in grove and packing house and in transit that there is as little opportunity as possible for even slightly injuring the skin of the fruit.

Blue Mold Decay

Every handler or shipper of oranges and grapefruit is familiar with blue mold by far the most prevalent form of rot in citrus fruits. There are two closely related forms of Penicillium either one of which produces so-called blue mold—the spores of P. italicum being blue-green and those P. digitatum olive-green. The blue-mold fungus belongs

to the class which has not the power to penetrate sound living tissue; there must be some break, abrasion or weakness of the skin through which the disease may find an entrance, but once started the fungus is capable of killing the surrounding tissues in order to obtain material on which to grow. The first indication of decay is a small area of soft tissue on the surface. This increases rapidly in extent if the weather is moist and warm and within a day or two a white mold develops which later produces a bluish or greenish powdery layer of spores. In cold dry air the growth of the fungus is retarded. Fruit which has been [fol. 468] so carefully handled as to preserve the skin in an uninjured, healthy condition develops practically no decay. It is apparent therefore, that the control of blue-mold decay is primarily dependent upon the improvement of the methods of picking, packing, and transporting the fruit.

Diplodia Decay

Two-thirds or more of the decay found in the many boxes of Porto Rican oranges and grapefruit examined in New York, while closely resembling in appearance the stem-end rot of Florida citrus fruits, has been identified by Mrs. Flora Patterson, the Mycologist of the Bureau of Plant Industry as Diplodia natalensis. In the early stages of the decay there is a softening of the tissue around the stem followed by a breaking down of the structure of the fruit and a dull, watery appearance of the skin. This spreads over the surface from the stem end or frequently from both the stem and blossom ends, the fruits becoming black and very light in weight as the decay advances.

PLAINTIFFS' EXHIBIT No. 26

Proceedings of the Twenty-seventh Annual Meeting of the Florida State Horticultural Society, Held at Palatka April 28, 29, 30, May 1, 1914

Compiled by the Secretary, Published by the Society

Packing and Shipping Citrus Fruits

S. F. Poole

MR. PRESIDENT, LADIES AND GENTLEMEN: I do not know why our President landed on me for this paper, not being

a packing house man, unless he wanted a filler for the pro-
[fol. 469] gram. I can assure all of you that you will not be detained very long. Anything of interest or new to the subject will be left to my colleagues on this committee.

I debated for a long time what to say on this subject and finally decided to present some of the aims and problems of the packing house in the Winter Haven district.

One factor that has undoubtedly contributed to the successful carriage of our fruit to market is our light thin soil. Such a soil produces a firm juicy fruit with a naturally tough rind. Yet in spite of our natural advantages, at all stages in the packing of the fruit the greatest care is exercised to prevent injury. At no time does the bare hand touch the fruit. All sharp corners on boxes, receptacles or carriers, are rounded off or padded to prevent injuries to the rind. The houses are kept clean. No trash or spoiled fruit is allowed to accumulate for the fewer are the chances to breed decay spores, the less will be the danger of infection. Extreme care and vigilance all along the line have been taken by the two best equipped houses, the Winter Haven and Florence Villa, to demonstrate to the fruit buying world that our brands can be placed on the market and sold with practically no decay. The average decay being only a small fraction of one per cent. The pickers are provided with sacks into which the fruit is carefully placed. When filled, the sack is lowered into the field boxes before the bottom of sack is unhooked. Every orange must be clipped close and square across; the clipper used is the Tuttle clipper. The pickers are subjected to a triple inspection. First, a constant one by the foreman, second, a frequent one by an inspector, and third by the owner or manager. The picker is furnished with number tags. As fast as a picker fills the box, he sticks a tag showing his number, under the metal of the strap. Whenever a box of fruit is inspected in the field, it is then possible to find out what picker may need attention. Too much stress cannot be laid upon good picking for we all know poor clip-
[fol. 470] ping will spoil the first-class packing. All fruit is picked by the box. The boxes are of the usual type with straight partition and hold about two thirds of a packed crate. These crates are easier to handle and are consequently not so apt to be slammed around. The filled crates

are loaded on to wagons furnished with bolster springs. These springs are tested to three thousand pounds capacity. Two types of loading wagons are employed. One requires 36 boxes and the other 45 boxes to the load. In the former fruit is stacked in one row four high in a line back from the driver. One long rope ties on the load. The other type of loading has three rows of 15 boxes each. These wagons are suplpied with side racks. Ropes are placed from side to side to prevent the slipping of load. All wagons must be furnished with five inch tires. These teams deliver the fruit to the packing house at a side entrance where it is trucked to its proper place in the receiving room of the packing house.

Arrangement of House

The fruit is stacked up north and south of the washer which is located on the east side of the center of the house. The drier and sizers occupy about two thirds of the length of the house in the center of the full space. The packed boxes are stacked up next the wall on the west side. This is the side next to the railroad track. The north end of the building is used as storage of the crate material and for the box-making machine. The office is outside and detached from the main house. Each grower has a number and at all times is known only by his number. These field crates are trucked to the soaking tank of the washing machine into which they are emptied. Here the fruit is allowed to remain some few minutes. More fruit is put into the soaking tank as fast as the fruit is carried up onto the brushing machines. The type of washer employed is the Lemoneira. Here the fruit goes through a narrow passage supplied with a fine spray where it is brushed and polished. The fruit it constantly turned over so that every particle of dust is removed from it. From here the fruit passes [fol. 471] on to the drip rack. At the very first stage of entering the drier, the fan blows air upon the fruit driving off most of the adhering water. The passage through the drier occupies about five minutes. Two ways of heating this air are employed. In one house the air is warmed by the exhaust of the gasoline engine, and in the other house the air is heated by a blast furnace burning crude oil. The

temperature to which this air is heated varies according to weather conditions from 100 to 180 degrees Fahrenheit. At the end of this passage through the drier, the fruit comes out upon the grading belts. Here the graders are seated. They are furnished with gloves on both hands, and they take the fruit and place each grade of the house upon separate belts. If there is any doubt in the mind of the grader where the fruit belongs, it goes into the next lower grade. Every orange doubtful as to its keeping quality, is a cull. Each house makes three grades based largely on the color of the skins. These belts carry the fruit down to the sizers. The type of sizer used is the Maull. The bins of the sizers are so arranged that the drop of the fruit is very slight, falling on a thoroughly padded surface thus avoiding injury to the rind. The packers at this point take the fruit, wrap it and put it into the boxes. This pack is about one to two inches high, the fairly tight bulged pack being used, so that the fruit may arrive in the market showing no slackness. A hookless type of box is employed as the fruit is shipped in carload lots. The boxes are placed in the car and held in place by strips. As an additional precaution the Winter Haven house is using a metal hook to hold the lid in the center. Very few cars are iced. Towards the end of the season for the mid-season fruit some cars of overripe fruit are either half or fully iced.

The two houses in this section handle all their fruit through the Florida Citrus Exchange whose methods of operation do not need to be described at this time. Fruit must be tightly packed and placed on the market with practically no decay. This decay must not appear before the dealer has had a reasonable time to sell the fruit. I wish [fol. 472] to emphasize once more that fruit carefully and attractively packed will ship sound.

Dr. O. W. Sadler, Mt. Dora

Mr. President, Ladies and Gentlemen: Having been appointed one of a committee on Packing and Shipping, I reviewed the reports on all the usual steps of the operation from trees to packing house, and through packing house to market, and found every point so fully dealt with, and

the results so thoroughly demonstrated by numerous experiments extending over seven years, by the Bureau of Plant Industry, represented here by Mr H. J. Ramsey, that there is very little to be said, further than to emphasize with all the force the English language can express that it pays and pays big, to use the utmost care in handling citrus fruits. Every grower should obtain a copy of the latest bulletin on the subject, No. 63, by the U. S. Dept. of Agriculture.

At last year's meeting of this society in Be Land, I made some remarks on one process in the packing of fruit which for the past three years has impressed me as being of the utmost importance, and capable of vast improvement—I refer to the Perfect Drying of Fruit after washing.

With the advent of whitefly and sooty mould, washing has become imperative, where they exist. On page 26 of bulletin 63, we find that carefully handled fruit not washed showed 1 per cent decay after 2 weeks, while the washed showed 4.1 per cent.

In the commercially handled fruit, not washed showed 3.6 per cent, while the washed showed 10.2 per cent.

From this test is shown that up to the time of these experiments, washing was the cause of 3.1 per cent decay in the carefully handled fruit, and 6.6 per cent of that commercially handled.

All the shipping experiments have demonstrated that Blue Mold is the chief form of decay.

Laboratory experiments have shown that blue mold is a [fol. 473] fungus, of the Genus Penicillium, and that these fungi require heat and moisture for their development.

From this last fact we get a hint as to the cause of increased decay following washing of fruit—moisture.

Let it be understood that my subsequent arguments are based on the supposition that the utmost care from tree to packing house, and through all steps in the packing house to car, including washing, have had the best management as to personal and mechanical handling; and that fruit, with a perfectly sound rind is not inoculable by blue mold,—yet, in spite of this utmost care, undiscernible injuries will pass the graders.

Prevention from decay from these undiscoverable—and accidentally overlooked injuries—has been the theme of my

studies. We have seen that "Heat and Moisture" are necessary conditions for the development of "blue mold." To control these, then, is our task. Weather changes of "Heat & Moisture" we cannot control. The first element—heat—of the combination, has impressed itself upon everyone, as the most fatal and important element of our dual foe—"Heat & Moisture." Vast sums of money have been spent to artificially deprive heat of its venom; by icing and precooling,—unwittingly adding more moisture—the second element in the combination that causes our ruin.

The unphilosophical idea of overcoming decay by artificial cold, will be seen on a little "cool" reflection. Cold induces precipitation of moisture in a warmer atmosphere than the cold produced; hence in trying to control our arch enemy—"Heat & Moisture," while we may have lessened to some extent the effects of heat, by cold, we have added more moisture, which we believe to be the most dangerous factor, as we know that decay, with moisture present, will go on, up to, and slowly, after the freezing point, and frozen oranges are not marketable.

In bulletin 63, page 48, we find: "The investigations of the Bureau of Plant Industry have demonstrated, that Florida oranges may be transported to market under ventilation, with a minimum of loss from decay, even during [fol. 474] periods of warm and humid weather, if sufficient care is taken to preserve the skin unbroken." And on page 50: "Precooling may not safely be depended upon to offset decay following mechanical injuries."

Precooling plus icing, are the last attempts at control of heat and decay. But in the presence of mechanical injuries—"cannot be depended upon"—are a failure, and expensive to the tune of 15c and more per box. Now I ask you to follow me in a philosophial study of the possibility and probability of preventing decay—"blue mold"—by turning our attention to the other element—moisture—number 2 of our arch dual enemy "Heat & Moisture." I say philosophical study, for there have not been millions of dollars spent in experiment on this half of the combination, as applied to shipment of citrus fruits. We may find it easier and cheaper to prevent moisture, than heat. If we can banish moisture, the heat necessarily encountered in the transit of fruit to market will become perfectly harmless.

Receiving encouragement from L. B. Skinner and other growers, as to the correctness of theory of drying fruit for shipment, I began correspondence to find the means for applying heat in the most controllable and cheapest way possible—steam radiation.

Although there were numerous manufacturers of steam heat radiating appliances for house-heating, etc., I found none who were prepared, or cared to adopt appliances to packing house plants.

Being a member of the "Lake Region Packing Association" at Tavares, I formulated my ideas of a system of applying pipes in a manner to utilize the old "hot air" drying box and drop rack, to the President, Mr. Wakelin, and Manager, Mr. Booth, of the association.

After carefully digesting the conditions, an expert contractor was called in, and the requirements laid before him. He approved of the plan, and fulfilled a contract to put in operation the necessary piping including a boiler "Guaranteed to give satisfaction," at a cost considerably less than $400. This drying plant consists of a set of wooden [fol. 475] rollers turning on their own axes, 38 feet in length by 3 feet wide, discharging the fruit onto another set of rollers 6 feet wide and 36 feet long. Both are enclosed in a box made of tongued and grooved flooring. Close under the rolls is a system of one-inch iron pipes—the first 12 and the other 24 pipes running lengthwise—each with an expansion joint, and connected to a large cross head pipe. The steam is supplied by a 10 H. P. upright boiler, set in a convenient out of the way location, and stop cocks so placed that the steam can be turned onto one or both systems of piping. A thermostat should be placed inside the drying box against the middle of the length of the side wall, also a thermometer. A fan is run in the chimney flue by a 3 H. P. motor at the far end from grading belt to draw off the air that has become saturated with moisture. By these means the desired temperature can be maintained steadily.

The capacity of both drying boxes is 30 boxes, and the fruit is 8 minutes passing through each, giving 4 cars in 10 hours, and the fuel cost has been $197 for the season—using coal. This cost would be lessened by nearly one-half, had all the coal been bought by the carload.

The results have been very satisfactory and controllable. So much so that the manager, Mr. J. B. Booth, does not believe there is a better drying plant in the state.

This house has to pack under very unfavorable conditions. Being a central house, considerable of the fruit is picked by inexperienced pickers, has to be transported across a lake on barge reloaded on car, in some cases hauled 30 miles, often being 3 to 5 days after picking before it is packed. Another disadvantage is that they have so much early and mid-season fruit they have to continue packing through the decay weather periods.

The past season the dry box has been kept at 98 to 100 degrees. It is my belief that the box should be kept at 120 to 135 degrees to secure a drying over of all injuries that have passed observation. There seems to be a general fear that the fruit might be cooked. It is yet left to experiment [fol. 476] how much heat fruit will stand without injury. The greater the degree of heat, the shorter time it need be exposed, quick drying of the peel with little heating of inside being desired.

A comparison of results of last and this season shows a vast improvement. Season of 1912-13, shipped 177,954 boxes; season of 1913-14, to April 24, 183,175 boxes. Last season's decay, 2.6 per cent, or 26 boxes per 1,000 boxes. This season, .0046 per cent. Or last season, 26 boxes per 1,000, or one sixth as much Dk. The greatest part of this difference can safely be attributed to the more perfect drying. Last season hot air in place of steam heat radiation was used.

With the laws of natural physics as a guide, and the few experiments made, we think it reasonable to conclude that heat by steam radiation is the most controllable, most efficient and cheapest method of drying fruit.

That the removal of, and prevention of moisture in transit, will be the easiest, cheapest and most effectual method of preventing decay by "blue mold."

We believe it very desirable that the Bureau of Plant Industry make as thorough test of preventing decay by blue mold by controlling moisture conditions, as have been made by precooling and icing to control blue mold.

Mr. Hollingsworth: What percentage of seedling fruit was in these shipments as compared with the budded stock?

Dr. Sadler: I cannot give you the percentage of seedlings.

Mr. Hollingsworth: Is it a fact that seedling fruit ships as well as budded stock?

Dr. Sadler: I believe seedling stock is more tender than the budded.

Mr. Bennett: I think one point that should be discussed is drying the fruit by electricity. As compared with any other method of heating the air, it is superior. The equip- [fol. 477] ment is very easy to put together, too. The expense is not great; I have dried perhaps 1,200 boxes of oranges per day at an expense for electricity of not to exceed 50c. Where you have the electric current the expense is about 1½c a kilowatt hour.

Mr. Hollingsworth: I would also like to ask if it is advisable to wash fruit where whitefly has not spoiled the fruit; where it is naturally bright and clean.

Mr. Hart: Florida fruit is not perfectly bright and clean. When the sooty mold is absent, the fungus is there. All of the markets now are used to bright, clean, handsome washed fruit, and if you put your fruit into that shape, it will pay you well with the little difference in the cost. I do not believe that fruit properly washed is any more subject to decay than that which is not washed. I know that a great deal of the fruit that goes into the market is weaker because it is washed. I do not think that is necessary however, I think it can be done without weakening the fruit. To get the top price on the market, I think it should be washed.

Dr. Sadler: Our house was fitted up first for drying with electricity and it used up so much money that we could not stand it. It would not be very advisable in almost all the points in Florida I know of.

David Scott, Arcadia, Fla.

Mr. President, Ladies and Gentlemen: In the packing of citrus fruit, two objects should be kept in view.

First. To secure the greatest possible keeping quality. This is the work of a scientist.

Second. To produce the most pleasing impression on the customer, which calls for the genius of an artist.

To secure keeping quality, mechanical injury to the tender cells of the rind should be avoided. The less handling and the shorter time from tree to box the better. Work here begins with gathering from the trees. In this process fre- [fol. 478] quently the greatest injury is done to the fruit. A good foreman, who can secure largest amount of careful work from pickers is of prime importance. Much also depends on equipment as well as careful workmen. All clippers should have rounded points, curving slightly from the fruit. This reduces danger of clipper cuts or long stems. One long stem will injure every orange with which it comes in contact. Hence may do ten times more damage than a clipper cut.

Sacks opening at bottom are preferable for picking low budded trees. But in case of tall seedling trees where long ladders are necessary, baskets are better, as the fruit is not so easily bruised. Each fruit should be held in one hand while the stem is clipped, then placed, not dropped, or thrown in the basket or bag.

If roads are rough, fruit should be hauled to the packing house in spring wagons, and in all cases protected from sun, dust or rain by canvas covers.

After fruit reaches the packing house, if smutty or dusty it should be washed and dried by artificial blast of warm air, after which it should be graded from grading belts, into at least four grades, five would be better. Bright, Fancy Bright, Russet, Golden Russet and seconds. In some crops it is not advisable to make more than one grade of russets. There are a number of good systems of packing house equipment. That which handles the fruit with least friction or dropping is to be desired.

A word as to packages. The trade almost universally demand bulge pack. The fruit should be placed in the boxes to fit close, slightly higher in middle than at ends, so that no severe pressure shall be necessary in order to nail down ends of cover.

There seems to be a tendency with some Florida packers to imitate foreign packages. The writer has found it pays

to stick to the old standard Florida box with birch hoops. They may look somewhat rustic, but when neatly made, with an attractive brand, the birch hoop, Florida box, like its contents, is in a class alone, and is immediately recognized [fol. 479] as the Florida product. The best in the world.

F. D. Waite

Mr. President, Ladies and Gentlemen: I have been placed on a committee to report on packing and shipping fruit. Before attempting this report I find that the ground has been most thoroughly covered in the past six or seven years by several government experts. In a meeting in 1907 Mr. Tenney gave his experiences in handling citrus fruits from the tree to the car, and the results of his experiments have been found practical and effectual in every detail.

For the benefit of new members I will state a few points that I think worth remembering:

In picking fruit we try to carry out Mr. Tenney's instructions especially to avoid rough handling, and by using the Tuttle clipper which we think superior to all others (as with it it is almost impossible to clipper-cut the fruit) and when a picker has confidence in the clipper he is using he will hold it nearer the fruit, thereby avoiding the cutting of long stems, which is so injurious to other fruit when passing through the different machines. We never use anything but the canvas-lined willow baskets, which I think are now recognized as the safest to use.

A great many have felt that in washing fruit they were starting it on the road to decay. We have been washing fruit by machinery for thirteen years, and only in exceptionally bad weather have we been troubled with decay; and I think it has been an acknowledged fact that when we have foggy, rainy, hot weather it is better to shut down the packing house and wait for cooler and dryer weather—or, if the crop must be moved, it should be shipped under ice. We find that half tank cars of ice are sufficient.

When equipping our packing house two years ago we tried to eliminate all chance of fruit being bruised by fall- [fol. 480] ing onto other fruit or into the packing bins. In putting in equipment the best is the cheapest, and I think it should be constructed so that the fruit can be automatically dumped on the roller conveyer and travel on a level through

the washing machine, drip rack, dry boxes, roller grader and sizing machines to the packing bins.

There is such a diversified opinion in grading fruit that I am loth to say very much on the subject. I have been in packing houses where they used color to represent different grades, and those grades were made irrespective of whether fruit was bright, golden or russet, being graded more as to texture of peel than to color of fruit. I think this is a mistake—the fruit should be graded bright, golden and russet, and we have one other brand which we use for the scarred or ill-shaped fruit.

We believe in a good, swell pack, each layer packed firmly and the sooner the fruit is packed and shipped after it is picked the better the condition will be on arrival. We use refrigerator cars, with vents open, which gives the best circulation of air.

I don't know that I have said anything in this report that has not already been explained to the Society, but there may be new members here today who have not had the advantage of attending former meetings, or an opportunity of reading the reports of the meetings.

W. Walton O'Hara

MR. PRESIDENT, LADIES AND GENTLEMEN: If I speak in a loud tone of voice, louder than seems necessary to those in the front, it is because I discovered when sitting in the rear that it was impossible to distinguish a word that was said by the speakers this morning.

This privilege accorded me here on this floor I deeply appreciate, and thank this [Omission in copy]

[fol. 481] Precooling and Handling Investigations with Oranges and Lettuce, Florida, Season 1913-14

H. J. Ramsey

MR. PRESIDENT, LADIES AND GENTLEMEN: The Bureau of Plant Industry of the United States Department of Agriculture has been conducting extensive investigations during the past six seasons in Florida relative to the relation of handling methods to decay of oranges in transit and on the market. The results of these investigations published re-

cently in Department Bulletin 63 clearly demonstrates that the decay occuring in transit and at the market end is due largely to rough and careless methods of handling. These results have been corroborated in commercial practice and you have all about you in the citrus section of this state clear-cut demonstrations of the practical application of the fundamental principles developed in these investigations. The results of the experimental handling and shipping and the results obtained in the various packing houses in this state clearly demonstrate that if a fruit is handled with sufficient care, it can be delivered on the market in practically sound condition.

There are, however, two factors which make it extremely difficult to continuously and under all conditions deliver oranges on the market in absolutely sound condition, and to have them remain sound for a reasonable time after arrival on the market. Under commercial conditions it is almost physically impossible to handle fruit with a sufficient amount of care to avoid inflicting injuries of some sort. High winds oftentimes are the cause of much fruit being thorn punctured on the trees, and it is impossible to grade out all such injuries in the packing house. If the weather following such winds is moist and rainy, there is certain to occur considerable decay, both in transit and on the market, which cannot entirely be avoided by the most careful methods of handling. Another factor which enters into the prob- [fol. 482] lem of delivering the fruit in sound condition is the stem-end rot more or less prevalent in most sections of the state. Decay of this kind cannot be controlled through careful handling methods.

Many of the leading growers and the industry as a whole have for some time felt that the blue mold decay, due to injuries more or less unavoidable in the most careful commercial handling, and the stem-end decay, which, during certain seasons or portions of a season may be very serious, could be held in check or largely prevented through the utilization of refrigeration or precooling. They accordingly requested the Department to extend the handling work to include pre-cooling investigations with oranges. The pineapple and vegetable industries of the state also made urgent requests for both handling and precooling investigations with a view to reducing loss and deterioration of these products in transit to a minimum. In response to these requests

and in view of the importance of the handling and shipping problems as relates to the marketing of the fruit and vegetable products of this state, the Bureau handling and shipping investigations were extended to include precooling of oranges; handling and refrigeration of pineapples; and vegetables, particularly lettuce. The orange precooling and the lettuce handling and precooling investigations have been in progress for but one season. Preliminary investigations with pineapples were commenced last summer and will be continued on a commercial scale this season providing crop conditions permit. We feel that the results here reported are only more or less indicative and should not therefore be accepted as conclusive. The data and results, however, obtained in these preliminary investigations are in a measure so striking and consistent with results of similar lines of work with other fruits and vegetables that it is deemed desirable to give them to the industry at this time.

Before taking up a discussion of the results of these variout lines of work, I think it would be well to discuss in a general way the subject of precooling. There seems to be a [fol. 483] misapprehension as to what precooling means or involves. The same is true to some extent as regards ordinary refrigeration. Precooling is a term used to designate the prompt and quick cooling of fruit, vegetables or perishable food products before shipment. It involves the cooling of the fruit and vegetables themselves, and not only the empty refrigerator car or the air only in a fully loaded one. The precooling may have several objects in view, the two principal ones being the delivering of the produce on the market in sounder and fresher condition and the cheapening of the cost of transportation.

The physiological and chemical changes that constitute ripening of fruits and vegetables go on with considerable more rapidity after the fruit is removed from the tree, especially if held in a high temperature. One of the objects of precooling, therefore, is to retard the ripening processes by retarding the temperature down to a point where the ripening processes will be checked or very materially retarded. This is not as important with citrus fruits as with quick ripening fruits like peaches and most other deciduous fruits. The rapid ripening of fruits in transit under ventilation or under ordinary refrigeration is oftentimes one of the causes of quick deterioration on the market.

In addition to this, there are various fungi which cause decay both in transit and on the market. The blue mold decay, as above mentioned, can be pretty well eliminated, through careful methods of handling. Stem-end decay, however, cannot be controlled in this way. When the blue mold or other fungi have commenced to grow, further growth is not absolutely stopped even at a temperature of 32 degrees. The spores of these fungi, being analogous to the seeds in many of our higher plants, germinate only under certain conditions of temperature and moisture. They do not readily germinate where the air is perfectly dry or when the temperature is very low. Another object, therefore, of precooling is to reduce the temperature down to a point where germination of fungus spores will not take place.

[fol. 484] There is also considerable misunderstanding in regard to ordinary refrigeration, but few people realizing the length of time that it requires for the ice to fully cool the contents of a refrigerator car. Temperature records that we have taken in fully loaded refrigerator cars enroute from California and other Pacific Coast points, as well as from Georgia to northern and eastern markets, conclusively show that it takes the ice from three to seven days to reduce the temperature in a refrigerator car to a point where the ice will finally hold it. During the first part of the journey much of the fruit is unaffected by the refrigeration, and the ripening processes and the development of decay continue under rather high temperatures. The fungus spores germinate while the fruit is still warm during the first part of the trip and the growth of the fungus, though finally somewhat retarded, continues somewhat during the whole trip. A number of temperature-recording trips were made with oranges from California to New York under various methods of refrigeration and precooling. Under full icing it required usually about seven days to reduce the temperature below an average of 45 degrees, and I see no reason why Florida oranges under full ice should cool much faster. During the first three or four days out, the decay develops at about the same rate as it would under ventilation, and the full effect of the icing is not obtained, especially as regards most of the fruit in the car, until the last day or so in transit. In the case of Florida shipments under full icing, there-

fore, the fruit is not all thoroughly chilled in the majority of cars even by the time it reaches the market.

You should all bear in mind that even though precooling has had considerable commercial application, particularly on the Pacific Coast, it is still more or less in the experimental stage and there are still many problems to be worked out in connection with the application of precooling the different varieties of fruits and to different sections. Illustrative of this is the problem of rapid cooling. In order to accomplish the cooling in the shortest time possible, [fol. 485] especially in car precooling, some of the fruit, at least, is necessarily subjected to temperatures considerably below freezing. Some varieties of fruit can stand very low temperatures without injury, with others it is necessary to run the temperatuers rather high even at the beginning of the precooling process in order to avoid injury by freezing or rapid reduction of temperature. The minimum temperatures that the various varieties of fruits and vegetables will stand without injury have not yet been fully determined.

There are two methods of doing precooling; that is, in the cars after they are loaded or in warehouse cooling rooms before the fruit is loaded into the cars for shipment. Where car precooling is employed considerable more refrigeration is required than in a warehouse room due to the leakage of air through the car walls. The cooling in a car is also necessarily more or less unequal, the fruits near the blast being cooled rather quickly while the fruits in the center of the car or half way between the doors will cool rather slowly. There is also a great difference, sometimes as much as 30 degrees during cooling between fruits in the outside of the package and in the center of the same box.

In a warehouse room the cooling can be accomplished with less refrigeration. As there need be practically no loss of refrigeration through the walls, the cooling can be somewhat more even or equal as the air can be distributed to better advantage. There is an added advantage in using a warehouse room for precooling in that the fruit can be placed in the room and cooled immediately after it comes into the warehouse. In the case of car precooling the actual cooling cannot be commenced until the car is fully loaded, and in many instances, moved to the precooling plant. This oftentimes involves considerable delay which

is fully as serious in the case of precooling as is the slow and delayed cooling under ordinary refrigeration.

In general it may be said that precooling at its best is an expensive proposition. It is essentially a business under- [fol. 486] taking. Anyone contemplating, therefore, the establishment of precooling plants should satisfy himself that it is a paying investment from the standpoint of delivering the produce on the market in sufficiently better condition to command a price commensurate with the expense involved in precooling. The Department instituted these investigations primarily to determine exactly what there is in precooling from a practical standpoint and what the effect will be on the various fruits as regards condition in transit and after arrival on the market. We have no particular system to recommend, in fact no recommendation for precooling itself, until we are certain that it is a desirable adjunct to the Florida fruit and vegetable shipping business. Preliminary results indicate that precooling in this state will have a large field of usefulness, but we feel that further extensive investigations are necessary before the status of precooling is fully established.

The granting of initial icing privileges to Florida shippers makes possible combined precooling and refrigerator at less expense than full ordinary refrigeration. During several months of the shipping season precooling with initial icing may be entirely practicable. This is a phase of the precooling and refrigeration problem that we want to test out fully the coming season.

The question of whether a mechanical ammonia plant or an ice and salt plant is best depends upon conditions such as number of cars to be precooled, length of season, cost of ice, labor, etc. Mechanical ammonia plants require rather heavy expensive machinery and expert attention during operation. There is, therefore, heavy initial expense, as well as a relatively high running charge. The practicability of utilizing such a plant will obviously depend upon the number of cars to be precooled and the length of season during which it can be operated. There are in operation several warehouse plants in California, designed for the precooling of oranges, built and operated by growers' association. Figures compiled by the Citrus Protective [fol. 487] League of that state give the average cost of precooling and initial icing in these various plants at $32.50 a

car. This in addition to the $7.50 charge for the use of the refrigerator car, makes a total refrigeration charge of $40 per car. The cooling is accomplished in from 36 to 72 hours in the different plants.

The Department has designed several ice and salt plants now in operation by associations shipping two to three cars a day of berries and deciduous fruits. The refrigeration is obtained by drawing air through a mixture of crushed ice and salt. The cold air is distributed in the precooling rooms and through false floors giving rather equitable cooling and the system is effective and entirely practicable where ice can be obtained at a reasonable figure. The cost of construction is relatively low, the insulated rooms being the principal item. Practically no machinery is required aside from the electric motors and fans and no skilled labor necessary in its operation. The cost of precooling with this type of plant is therefore dependent largely on the cost of ice.

Orange Precooling Experiments in Florida 1913-14

The precooling experiments with oranges were carried on at Palmetto, Florida, the fruit for precooling being obtained from the surrounding section in Manatee County. Conditions over which we had not control made it impossible for us to carry on these investigations in just the way we had planned. On account of crop and market conditions it was impracticable to obtain any number of cars going to the same market, and during the major portion of the season it was not even possible to have the precooled and comparable check cars sent to any one point. This made it necessary to make the inspections at Washington, forwarding the experimental lots by express from the different points to which the cars were consigned. The difference in the time of arrival and the different lengths of haul by express in many instances made impossible a correct determination of the effects of precooling on the particular lots. [fol. 488] The difference between the precooled and the non-precooled lots very often were not discernible by the time the fruit reached Washington, the comparable lots arriving sometimes a week or more apart. The conditions above mentioned made it necessary to discard a number of shipments in making up the data. We have, however, a fairly

good line on the effects of precooling in the holding lots held at Palmetto. Comparable lots in the precooled and non-precooled series were held in a fully iced car at Palmetto to check up the results of the shipping experiments. These holding lots of both precooled and check series furnished the most dependable data we have this season on the effect of precooling. These were all held in the iced car for ten days, were inspected once on withdrawal and one or two weeks after withdrawal. The following table gives the data on fifteen series of commercially handled fruit, both precooled and non-precooled held in the iced car. On withdrawal there was about three times more decay in the non-precooled than in the precooled.

Orange Holding Lots 1913-14, Commercially Handled—15 Series

Blue-mold Decay

Time of examination	Non-precooled	Precooled
Withdrawal	3.5	1.2
After 1 week	15.0	10.7
After 2 weeks	19.6	16.6

Stem-end Decay

Time of examination	Non-precooled	Precooled
Withdrawal	0.3	0.1
After 1 week	10.8	4.1
After 2 weeks	33.5	25.8

Total Decay

Time of examination	Non-precooled	Precooled
Withdrawal	3.8	1.3
After 1 week	25.8	14.8
After 2 weeks	53.1	42.4

[fol. 489] While the differences are not so striking one or two weeks later, nevertheless they are consistent. There was little or no stem-end decay on withdrawal, but one week later, the precooled showed 4.1 per cent as compared with 10.8 in the non-precooled. Two weeks later there is also a consistent difference. It is interesting, therefore, to compare the total decay in the precooled and the non-precooled

lots, that is, the total of stem-end and blue mold decay. On withdrawal there was three times more decay in the non-precooled than in the precooled. One week later the non-precooled showed almost twice as much decay as the precooled. Two weeks later the differences are not so great but consistent. At the time of arrival the fruit usually shows little or no stem-end decay. However, at the end of one week there is a considerable development of this trouble and the effect of precooling is here most pronounced. The following table gives the results of an average of 14 shipments during December and January, seven of these being precooled and shipped under half ice, the other seven under ventilation only.

Precooling and Icing vs. Shipping under Ventilation Commercially Handled

Average of 14 Lots Shipped During December and January

Blue-mold Decay

Time of examination	Non-precooled	Precooled iced
Arrival	4.7	0.5
After 1 week	10.4	3.1
After 2 weeks	12.7	8.1
After 3 weeks	14.7	12.5

Stem-end Decay

Time of examination	Non-precooled	Precooled iced
Arrival	1.6	0.04
After 1 week	9.8	1.4
After 2 weeks	21.5	7.6
After 3 weeks	37.6	28.1

[fol. 490]

Total Decay

Time of examination	Non-precooled	Precooled iced
Arrival	6.3	0.5
After 1 week	20.2	4.5
After 2 weeks	34.2	15.7
After 3 weeks	52.3	40.6

While this is hardly a fair comparison, it does bring out rather strikingly the effect of temperature and quick cooling as regards decay and deterioration in transit. The effect of temperature on the development of stem-end decay is here even more striking than in the holding lots. In the fruit under ordinary ventilation there is 9.8 per cent after one week on the market as against 1.4 in the precooled and iced. A discussion of these figures is hardly necessary, but in drawing conclusions from them, one should keep in mind the fact that the check lots were neither precooled nor iced. A number of comparable shipments of both precooled and non-precooled fruit was sent out without any ice whatever and the following table gives an average of 14 shipments, precooled and non-precooled, shipped without ice. The difference between precooled and non-precooled on arrival.

Oranges Precooling and Handling 1913-14—Average of 14 Shipments Shipped Without Ice

Total Decay

Time of examination	Careful pick & pack		Com'l pick & pack	
	Precooled	Non-precooled	Precooled	Non-precooled
Arrival	0.1	0.2	1.7	4.8
After 1 week	0.9	0.7	10.4	11.0
After 2 weeks	2.0	3.1	17.4	19.5
After 3 weeks	3.0	4.9	20.8	28.5

are consistent with the data already given. At the end of one, two and three weeks, however, there is little or no difference in the amount of decay. The long express shipments from various market points may, however, account for the apparent inconsistencies in these figures as regards [fol. 491] decay at the end of one and two weeks. You will observe that the effect of handling is even more striking than that of precooling and fully corroborates the work carried on by the Department for a number of seasons past. The results of these investigations this past season, I think, should be considered only as indicative. The holding lots give the most dependable data. The data obtained from the shipping experiments is not quite as satisfactory owing

to the impossibility of having the cars sent to any one market. The fact, also, that no initial icing rates were not in effect the past season made it impossible to obtain cars for precooling with initial icing only. This next season, if crop and other conditions are favorable, we will take advantage of the initial icing privileges recently granted and will carry on the experiments at some point or locality where a number of cars are sent regularly to some one market. This will permit of inspection of fruit of both precooled and non-precooled lots at one point and at the same time. In addition, temperature records will be taken in transit of a number of cars in order to obtain accurate and definite information in regard to temperature conditions in transit, both in precooled and non-precooled cars under both full and initial icing. The data above is given only as being indicative of results that may be expected under more favorable conditions for carrying on these investigations.

[fol. 492] PLAINTIFF'S EXHIBIT No. 27

Vol. XXV. Part 11. November 2, 1914

The Agricultural Gazette of New South Wales

Issued by Direction of the Hon. W. G. Ashford, M. L. A., Minister of Agriculture

P. G. Gilder, Editor

By Authority

Sydney: W. A. Gullick, Government Printer, 1914.

Fungus and Other Diseases of Citrus Trees

G. P. Darnell-Smith, B. Sc., F. I. C., F. C. S., Biologist, and Ewen Mackinnon, B. Sc., Assistant Biologist

The diseases of orange orchards are for the most part due to fungus parasites, which may be kept in check by sprays. Unfortunately spraying is not usually adopted until a disease has made its appearance; some times, only

those trees on which the disease has become manifest are treated, and more often it is not carried out systematically even upon those.

It would probably pay to spray the whole of every citrus orchard at least once with lime-sulphur just after the fruit has set. But even before that stage there is something the progressive grower should do—he should cut away all affected parts, and as the fungal hyphæ have been traced deep into the living tissue, he should not hesitate to cut as much as 4 inches of live wood below the affected part. There is no doubt whatever that this policy would pay—rigorous as it appears—diseased wood being the chief source of infection, and practically unaffected by any spray. The future shape of the tree and the time the operation takes to carry out are but secondary considerations. [fol. 493] All such prunings must be burnt.

Growers have a tendency to hope that one spraying of some particular specific will prove a complete remedy when disease breaks out. Those who do so ignore the teaching of biology, that the first essential is to remove the source of infection. The cost of thoroughly overhauling the trees, and of removing all infected wood in the first instance, must be looked upon as an investment which will return good interest if thoroughly done. Massee, speaking of apple scab, says:—"The young apples are mostly infected by spores produced upon the leaves. But the leaves could not become infected except by spores produced on diseased shoots, consequently diseased shoots are the source of all the mischief; hence, the most natural thing to do under the circumstances is to remove and burn all such diseased shoots. This is what I have advocated, but I have been told by a professor of mycology and a professor of agriculture, independently and in public, that this is not practicable. I am not convinced. I believe that it is as practicable to remove the dead shoots from the tree, as it is to remove the apples." In regard to the treatment of diseased trees we agree with Massee.

It has been stated above that the fungi causing disease are parasites. A parasite is entirely dependent, as a rule, for its existence on some particular organism or limited group of organisms, which constitute its host or hosts. So long as the nutritive or multiplicative function is the most important one in the life of a parasite, and until it has ma-

tured its propagative phases, the death of the host is the greatest disaster that can befall it. The ideal host, from the point of view of a parasite, is one that is "tolerant" to it—that is to say, one that can support the presence of the parasite and keep it supplied with the nutriment it requires, without suffering in health and vigour to any marked extent.

The effect produced by a given species of parasite upon a given species of host is a specific reaction, which differs markedly when one of the two dramatis personæ is changed. [fol. 494] Further, any alteration in the condition and surroundings of the host affects the parasite. Hence a particular disease is more prevalent in one district than another, and one may even find trees in an orchard suffering from disease, and other trees not far removed able to withstand the attack. The more vigorous the tree the less chance there is of its being attacked by disease, and the greater chance there is of it, if attack-, throwing it off or "growing out of it." The practical moral of the foregoing is cultivate and manure. When it has been determined that a disease is caused by a fungus, the sprays recommended are Bordeaux mixture or lime-sulphur. The frequency of application must depend on the time of the year and the weather conditions. Bordeaux mixture is very easily prepared, and generally speaking appears to have a more lasting effect than lime-sulphur, but it renders the foliage somewhat harsh, and has a certain detrimental action in retarding the free growth of the tree. Lime-sulphur can be applied more freely and more often than Bordeaux mixture; it leaves the foliage bright and glossy, and only when applied in excessive strength will it damage the appearance of the fruit.

Theoretically, the ideal method of protection from fungus attack would be to keep fruit continually coated with a fungicide. Practically this is impossible, because (1) the fungicide when applied even in a spray always runs together into droplets, owing to the waxy nature of the exterior of the fruit; and (2) the fruit is always growing and the fungicide, being non-elastic, soon cracks. More is to be expected from frequent spraying with a dilute fungicide than from one drastic spraying with a strong one.

The following sprays are recommended for fungus diseases on citrus trees.

Lime-sulphur Solution:
53 lb. freshly-burnt quicklime.
100 lb. flowers of sulphur.
50 gallons of water.

[fol. 495] Weigh out the lime and sulphur, place in an iron boiler and add 25 gallons of water; stir thoroughly. There will be a certain amount of spurting as the lime slakes; avoid being spalshed. Now add a further 25 gallons of water, and boil for one hour. Restore the water lost by boiling so as to keep the whole up to 50 gallons. This concentrated spray should be used shortly after making. For use on citrus trees, dilute 1 gallon of the concentrated lime-sulphur solution with 20 gallons of water.

Bordeaux Mixture:
Copper sulphate (bluestone), 6 lb.
Freshly-burnt quicklime, 4 lb.
Water, 50 gallons.

Measure out 25 gallons of water. Pulverize the bluestone and place it in a coarse sack. Suspend the sack just below the surface of the water until all the bluestone has dissolved. Slake the lime in a small quantity of water; then add 25 gallons of water and stir. Pour this milk of lime slowly, in a fine stream, into the solution of bluestone. When made, hold a bright steel knife for one minute in the solution. If a deposit of copper is found upon the knife the solution is not safe to use upon foliage—it will "burn" it—and more milk of lime must be added until no deposit of copper is formed upon the knife-blade.

Ammoniacal Copper Carbonate:
Copper carbonate, 5 oz.
Ammonia (26° Baumé), 3 pints.
Water, 50 gallons.

Mix the copper carbonate in a wooden pail with sufficient water to make a thick paste; next add the ammonia to dissolve the paste, and when all is dissolved dilute with water to make 50 gallons

This preparation is frequently employed where a strong fungicide is needed and where the colour of the Bordeaux [fol. 496] mixture renders it objectionable. The ammoni-

The Truth About Florida

The FLORIDA GROWER

Vol. X. No. 8. Tampa, Florida, May 23, 1914 Single Copy, 5 cents

STOCK ON VALRICO DAIRY FARM

MANAGER F. S. POND

Notes on the Eustis Citrus Growers' Association's Packing House

1. The building is a truss-roof structure 80x150, and contains no posts. The sides are corrugated galvanized iron. The roof is imitation asbestos. The cost of the building, real estate, and all equipment, was $24,400.

2. The house equipment cost $12,027.

3. Field Boxes—We have 5,000 field boxes, which cost us 24 cents apiece, knocked down. It costs 4 cents to make and stencil a box. We consider this box the best and most convenient box made for the handling of fruit. Its advantages are: It is light, convenient to handle and does not tip over in the field or on the wagon, being flat. A man is able to handle this box all day with perfect ease to the fruit. It loads on a wagon easily and is handled by the hauler without any serious damage to the fruit.

4. We receive fruit at the door on a pair of platform house scales. All pools run twenty days and every grade is paid by the pound only.

5. At the hopper we are connected with a roller belt. At this point we are able to remove all damaged or decayed fruit and leaves and sand that may be collected in the boxes. We claim that this is essential to avoid polluting the wash water. In our wash tank we use from five to seven pounds of most any kind of washing powder to remove the whitefly. The elevator from the washer to the washer is our own idea, and we think you will approve of it after an examination.

6. We use the Limoneira washer, which we think is the equal of any washer made when properly adjusted, the proof of which we have in this years' reports. We have neither lost nor had a per cent of decay since January.

7. Dry System. We have 112 feet of rollers—50 feet of which is open, termed the "dip rack" and 62 covered by a perforated tin box six feet wide, four inches deep at each end, nine inches deep where receiving the blast, and 62 feet long. This is placed 7½ inches above the rollers, giving a direct current downward on the fruit rolling by. This has proven entirely satisfactory, drying the fruit thoroughly in all kinds of damp and rainy weather. The drier connects with a boiler, which connects with a series of radiators, from which, in case it is necessary, we can take hot air or use a cold blast as some have advocated. Our boiler is also connected to our wash tank in which we try to keep the water between 80 and 90 degrees by the adjustment of the steam in the coils therein. It takes 15 minutes for fruit to go from the washing tank through the washer, drier and polisher.

8. After passing through the drier, our fruit is passed through a horse-hair polisher nine feet long with four runways. One side of the rollers in the polisher presses against cakes of paraffine, which are adjustable. This furnished a perfect polish, and we think gives a preservative element to the fruit. The machine is a spiral one and is known as the Stebler, which is hereafter to be made in Florida.

9. Our fruit then passes onto a roller grading belt and from that goes to the different grades through a series of automatic weighing machines, which mechanically registers the exact number of pounds placed in each grade through the weighers, leaving no possible chance for argument as to each growers' correct weights. The oranges pass into distinctive grades through the non-drop California Iron Works' sizer. We have three of them. The grapefruit is automatically weighed the same as the oranges and then passes through a Stevens' ball sizer, which we consider after using the past season to be as good a machine for sizing flat or oblong fruit, that we have ever had the pleasure of using.

10. Our conveyors are of the sprocket and chain with a loose pulley adjustment at the discharge end. The automatic adjustment of the belt is our own idea. It is very simple and its cost is naught.

11. We use the Covey Press for nailing on the covers. This is a very satisfactory machine, and as no part is made of wood, its life is practically unlimited. This is the machine that is used in all California houses.

12. The machine for making boxes is the Moryan. On it we have made all our boxes this year at an approximate cost of 25 cents per hundred.

13. Our car brace is a very simple appliance, made of two 2x4's, with spikes on either end and a hinge about 18 inches from one end. They very effectively keep the load from being torn up during the switching of cars. This is our own idea as well as the single box squeezer, which is made by two triangles placed about 2½ inches apart on a bar of iron furnished a lever of about three feet. With this we are able to move a row of boxes after being stripped to give ample space for the last box.

14. Our power is derived from five electric motors—four 5-horse-power and one 5-horse-power, which are connected in series and have control of their own part of the work separately. We are thus able to use any one or all of the motors and the parts of the machinery that they control as we see fit. The electric lights are on eight series, of which we have control by individual switches.

F. S. POND.

ANNUAL MEETING CITRUS ASSN.

The Eustis Association Holds Meeting

The annual meeting of the members of the Eustis Citrus Growers Association was held at the packing house at Eustis on Tuesday, May 5th, at 2 P. M. There were members present and proxies to represent 69 members. After the reading of the minutes of the past annual meeting the courtesy of the floor was extended to C. E. Woods, editor of the Eustis Lake Region. The report of the Auditor of the Florida Citrus Exchange, Mr. C. H. Allan, was read and a vote of thanks was extended him for the careful and courteous manner in which he had investigated the financial condition of the association. A report was also made by the secretary and manager, F. S. Pond, showing the results of the season's work to date to be as follows, as of May 5, 1914:

Varieties	Boxes Shipped	Amount Cash packing house	Av. per box Cash packing house	Net per box to grower
Oranges	30,561	$30,892.79	$1.0566	$1.0566
G. fruit	7,272	17,285.86	2.376	2.7622
Tang.	457½	15,243.30	3.718	2.1003
Mixed.	317½	661.37	2.102	1.6922
In transit	2,682			
Totals	41,227	$70,080.47		

The next thing on the program was the election of Directors, which resulted in the election of the entire old Board, with the exception of filling the one vacancy, Mr. Philip Prioleau being elected to fill this place. As the Board of Directors now stands it is composed of Messrs. Philip Prioleau, H. H. Allen, A. M. DeWitt, W. M. Moore, S. L. Harris, G. W. Holmes and J. P. Felt. A vote of thanks was extended the old Board and the management for the efficient manner in which they had conducted the business during the past season. Then the meeting was adjourned. After the adjournment of the members' meeting, the newly elected Board of Directors held a short meeting, in which Mr. Philip Prioleau was elected President, Mr. A. M. DeWitt,

THE NEW EUSTIS PACKING HOUSE—"THE DREADNAUGHT"

Vice President; F. S. Pond, Secretary and Manager; Citizens Bank of Florida, Treasurer, and G. W. Hollmon, Director to the Highland Citrus Sub Exchange or his own successor. There being no further business to come before the Board at the time, the meeting was adjourned.

F. S. POND, Sec. and Mgr.
(Lake Region)

NEED OF EVERY-DAY FARMING

A traveler returning from Florida, tells us that with a vision in his mind of tremendous area in sandy lands, Everglade, Hammocks, Swamps and Lakes. Here and there are citrus groves and truck farms. He is apt to see a picture of Pullman cars and high-priced hotels. He sees a world of fruits like come out of the cans. There is a sad lack of good meats, and of eggs, milk and fowls. He notices the beans and cattle foods, such as corn, hay and flour, and all the products from the cow and the hen, are scarce. In the land of vegetables, fruits, he may be, he is served with these things out of cans.

To such an one, there comes the thought that Florida while she may be successful citrus and truck crops (dirt work belongs to specialized writers), yet it must seem to him that there is a sad lack of common place everyday farming. He sees a great need, as to why the importation of various foods stuffs should be cut short.

Florida's lack of the above things is to become the reason producer there.

Florida, in very fact, is the very best habitat of any State in the Union, for various legume plants. These legumes not only furnish an extra amount of forage, as compared with non-legumes, but they also will enrich the soil. Florida has a fortune if she will only take it in her bejeanwered, her velvet beans, her peanuts, her Iron and Brabham cowpeas, among the legumes. In velvet beans she has the White Yokohama for September gathering, and for gathering some forty days later the White Chinese, a little later the White Lyon, and a little later the Specific Velvet Beans. She is by far better adapted for growing peanuts, such as North Carolina peanuts, white Spanish, red Spanish and Valencias, than are North Carolina and Virginia. It is the best State in the Union for growing chufas. It is by far the best State in America for growing sweet potatoes, such as Pumpkin Yam, Nancy Halls, Triumph, Vinelese, Pumpkin Yams, Red Bermuda, Sugar Yam, and Porto Rico. In Florida, one can have fresh potatoes practically all the year. No State in the country has two such hay grasses as Rhodes and Natal or Red Top. These are perennial and take just as well as Timothy. The New Sudan Grass is suited most excellently for Florida. Suitable, too, and perennials also, are mixed Bermuda and Burr clovers—which give on all the year green pasturage.

The above grasses and legumes would indicate, it might seem, cattle. But many of the rents seen in Florida would make a Chicago man smile. But if Florida "Would only make up her mind to but cut ticks, she could beat, four to one, the northwestern man, on the cattle industry. Spraying is not the difficult thing that many reared it, who would grow cattle. There are special cheap spray machines made for the purpose; and the material as used by the government is called Tixol, which is not costly. It is an arsenical preparation. It is difficult sometimes to get united action and to get co-ordinate work in a whole State; but these are things, as indicated above, which every land owner in Florida could take up in a personal way and do, and without waiting for his neighbors to act.

The Poultry Industry could be larger developed in Florida. We have found that one hundred birds can be pretty well fed upon one-half acre of ground. Put down one-fourth of this one-half acre to rape (almost any time of the year). Put down one-fourth to collards and one-fourth to oatrich plums mustard, one-eighth of it to oats and one-eighth of it to turnips. Most of these goods can be fed over and over again, and fed—the plants putting out another crop each time. N. L. WILLET.

FLORIDA LANDS

For Citrus Fruits, Truck Farms, Artesian Wells, Irrigation and small tracts. Improved Farms and Groves.

Write for Circular-Map.

MORGAN LAND COMPANY
Fort Ogden - - - - Florida

RUBBER STAMPS

Every grower needs rubber stamps for marking crates, baskets, hampers and for many purposes in his correspondence, billing, etc.

Every package must have them. We are the live Yes! make them. Get our prices.

THE GALLEY STAMP & SEAL CO. TAMPA, FLA.

Take a Dip in the Surf

SURF bathing, fishing, horse-back riding, driving, automobiling, dancing, pool, billiards, an unexcelled table and spacious homelike rooms, are but few of the joys of the world's greatest beach—35 miles long, 200 feet wide at low tide and as smooth as a macadam road—which you may enjoy at the

Atlantic Beach Hotel

ATLANTIC BEACH, FLORIDA

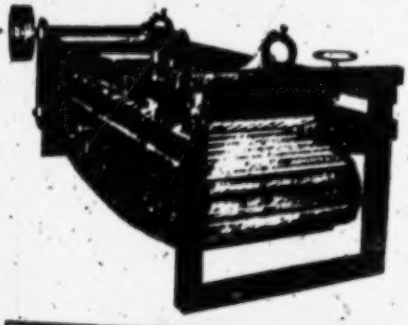
$60,000 expended on improvements to this far-famed hotel make it one of the best appointed on the Atlantic Coast. Seventeen miles from Jacksonville; eighteen trains daily. Special summer rates—$17.50 per week for one person; $30.00 for two, without bath; $35.00 for one, parlor; $45.00 for two, with bath; American plan.

Booklet on Request.

H. M. STANFORD, Mgr. Atlantic Beach, Fla

and Fully Enjoy Life

Real Packing House Equipment --- 100 per Cent Efficient



Read This Evidence --- That is Efficiency

BOWLING GREEN, FLA., April 14, 1914.

Gulf Iron Works, Tampa, Fla.,

Gentlemen.—Have your letter of the 8th.

The machinery you installed for us at Frostproof is very satisfactory.

Its efficiency can be no better illustrated, when I personally put an egg in the soaking tank, which passed through the whole machinery and came out at the other highly polished and perfectly sound. Its capacity is unlimited.

Very truly yours,

J. GENTILE & CO.

Others as Good on File

This cut is of our WASHER which showed by its record last season that it Scrubs fruit Clean, is Positive feed, does not bruise even the softest fruit and will wash five cars a day.

WE BUILT THE SIZER AT EUSTIS

The Gulf Iron Works Sizer at Eustis was built specially by us for the Eustis Citrus Growers Association because they realized (as all who installed them now do) that it is the only ACCURATE sizer of UNLIMITED capacity for IRREGULAR shaped, as well as ROUND fruit.

OUR BOX PRESS has proven to many pleased customers its money-saving, profit-improving qualities.

Drying System Improved

The drying systems we installed show conclusively that we have the RIGHT method for DRYING fruit. Our system this year is vastly improved—requiring no heated air.

If you Want to Be Satisfied

Buy Gulf Iron Work's Equipment and have the same pleasing results as the "wise ones" last year.

Prompt delivery. Low per-box-per-day cost. Minimum upkeep.

If You Contemplate a Packing House, Write Us for Plans and Specifications

GULF IRON WORKS, Tampa, Fla.

State Agents for Acme Steel Goods Co. Galvanized Strapping Carried in Stock.

acal solution discolours foliage and fruit to only a slight extent.

Blue Mould

This is usually due to the presence of fungi belonging to the genera Penicillium and Aspergillus. These are not true parasites, but they occasionally make their appearance on fruit hanging on the trees in a very wet season, causing it to quickly rot throughout. The spores are universally distributed, and any abrasion of the skin or any bruise may form a point of attack where the fungus spores can lodge and develop. The fungus grows with great rapidity, and produces enormous numbers of spores. One rotten or infected orange in a case may be the source from which infection spreads throughout the whole. While very little damage is done to fruit on the trees, enormous damage sometimes occurs owing to these fungi rotting fruit in transit.

The best remedy is to avoid most carefully any injury to the skin, and then to wrap each fruit in paper; the spores are thus prevented from spreading, and the disease is limited to fruit infected before it is packed. There is no doubt that the careful wrapping up of each fruit in paper and the periodical spraying of packing-houses and fruit-cases with formalin solution—1 part of commercial formalin in 100 parts of water—would greatly limit the loss that arises from the decaying and rotting of fruit in transit. The paper used for wrapping should be carefully stored, and only the required quantity taken out of store at one time, for if it is allowed to lie about anywhere the paper itself may become infected with spores.

Sooty Mould or "Fumagine"

This disease (due to Capnodium citricolum, McAlp.) is, in the aggregate, very injurious. Trees largely covered with a sooty fungus are sometimes

(Here follows reproduction of pages 497, 498, and 499 & 500.)

[fol. 501] PLAINTIFF'S EXHIBIT No. 29

Porto Rico Progress, an Independent Newspaper Issued Every Wednesday

San Juan, Porto Rico, Wednesday, December 23, 1924
Volume VIII—No. 1. Price 5 Cents

The Rot of Citrus Fruit

G. L. Fawcett, of the Agricultural Experiment Station at Mayaguez, has prepared the following paper on "The Rot of Citrus Fruit" which relates some of his recent findings:

"A few months ago on beginning to study the decay it was thought to be due almost entirely to the anthracnose fungus and the other common species which covers the fruit with a bluish mold. Afterwards it became evident that although both of these cause rots of the fruit that the main part of the decay had another source and was caused by a black sterile fungus. This fungus which was obtained from many of the fruits resembles closely a similar growth which has been called Diplodia natalensis in Florida where it is known principally as a gum producing fungus. It is probable that the two are identical. Introduced into healthy fruit it invariably produces at the point of infection a typical "Diplodia rot" within two or three days.

"The decay in question usually form at the stem end, about which the fruit assumes a sort of flesh color and softens. Soon this softening and discoloration extend to the entire fruit. The fruit then becomes darker and later, as may be seen in piles of old fruit, blackens and shrivels. The other rots develop from wounds or from infections apparent at the time of picking. The loss from decay in Porto Rican fruit is large in oranges, the percentages of loss often reaching twenty by the time the fruit reaches [fol. 502] market. In grapefruit it is much less injurious. In several boxes examined in New York, soon after they had been unloaded I found a few boxes to be free from decay but in most it occurred from one to four per cent. In some boxes of oranges of the same shipment there was fifteen per cent of loss from rot. In one lot of boxes of fruit provided by one of the large plantations I have found the

loss to reach forty per cent in some of the boxes twelve days from the time of packing although the average of loss for all was thirty per cent. Possibly the higher temperature here caused the percentage to be greater but in any event it is certain the loss from decay is large.

The fungus producing this rot seems not to form spores on the fruit or if at all rarely. I have examined large numbers of the fruit including the piles where the bad fruit had been thrown from time to time for months and have never found the spores. This fact is of practical importance in that it shows that it is not a packing-house trouble. Unless spores are produced it is impossible for one fruit to infect another except by contact. Even in the boxes where infection of healthy by diseaseed fruits might take place by contact this seemes to be unusual as in experiments I have found that only when slight wounds were made on the surface of the healthy fruit could it be infected in this way a decaying fruit. In boxes of fruit from which the diseased fruits have been removed every few days the percentage of decay continues as large as in those in which the *the* rotten fruit was left. This must not be taken to mean that carelessness is to be permitted any more now than before. The bad fruit should be gathered and removed if for no other reason than to avoid the other spore forming fungi of decay. For the same reason care in picking and handling the fruit is desirable. Occasionally the first rot to appear in the fruit is that of the slow developing anthracnose fungus, which has obtained entrance through a wound. But this seems to make conditions so favorable for Diplodia it develops from some hidden point of infection and finished [fol. 503] the decay whereas without such assistance it would have remained undeveloped. Although care in handling the fruit is therefore desirable it only indirectly affects that form of the decay caused by Diplodia.

"The infection of the fruit must almost always take place when the fruit is still attached to the tree. On examination I have found the fungus which causes the rot to be very common on the trees and by inoculation have found that it causes the same rot as that so common in the shipped fruit. Diplodia is more common in the branches that have recently died than the die-back fungus and seems to be more often the cause of injury to the trees. It has been

isolated from spots on the leaves and is frequently to be found on the branches and twigs so common on large trees nearer the trunk. The death of such material is normal as it is cut off from the light by the growth of new foliage. The spores seem never to be formed in abundance, but they are always to be found on such material which must * * * *tion.* Infection of healthy twigs by Diplodia does not mean that they are at once killed. Healthy branches resist artificial inoculation. Only when the conditions become unfavorable to the tree, as in drouth or when the tree has insufficient food can it become active on the branches. But slight infection of the fruit by Diplodia, either by spores lodged in the calyx at the point of attachment or by growth from inconspicuous infection of the stem itself, would be sufficient to cause later the decay of the fruit. Often the infection develops slowly, the rot sometimes appearing in grapefruit several weeks after it is picked. All the fruit appears sound at the time it is cut, but it is only a question of time until the rot develops in the ones infected. That the grapefruit seems less subject to the disease than the orange is probably because of the pr tection afforded by its thicker rind and not because it is any freer from infection.

"It was not expected from what had been noticed that dipping the fruit into a fungicide would give beneficial re- [fol. 504] sults as such disinfection must be very superficial at best and hardly able to penetrate to the point of infection which is apt to be well into the tissue at the stem end. Spores germinating on the surface would be prevented from penetrating the fruit by such treatment and, as we have noted, it is not a question of spore infection from other fruits. However, oranges were dipped immediately after being brought into the packing house into a two per cent solution of copper sulfate for five minutes. This fruit later showed a somewhat larger percentage of decay than fruit picked at the same time but not placed in the solution. Similar results were obtained with grapefruit. It would seem clear that this solution is of no value so used. It is not believed any solution of penetration and disinfecting power to kill the infection and not injury the fruit will be found, but further work in this direction is being carried on.

"Any treatment leading to the reduction of the amount of Diplodia infested material in the trees can be expected to give beneficial results in the degree to which this reduction is really effected. Undoubtedly it can be got rid of to a large extent by pruning out the dead branches and twigs. Not all such material bears the rot fungus but it is safer to remove all. This pruning should be repeated often enough to prevent the spores of Diplodia (which I have found only on dead twigs and branches from being formed. There is also reason for confidence that spraying with Bordeaux mixture will give good results as it can not but prevent new infections of stems and fruits at those places which it may cover, although not preventing the development of old infections. The best time for spraying to prevent spore infection of the fruits would be when they are well grown but still unripe. If owing to abundance of scale or the prevalence of drought, which is so unfavorable to beneficial scale destroying fungi, or because the scale are already abundant it is thought best not to use Bordeaux it would be well to at least try lime and sulfur in strong concentra-[fol. 505] tion which although a weak fungicide should be better than no spray.

"The fungus causing this rot occurs in Florida but is referred to there usually as causing gummosis. Infections made into branches with the Porto Rican fungus also cause gummosis but it is only of importance here as a fruit fungus, although it also under certain conditions can cause a "die-back". The same fungus is also, apparently, the cause of a root disease which is killing trees in one of the plantations. That it does not figure more largely as a disease of the fruit in Florida is probably to be explained by the fact that there the period between picking and marketing is much shorter than here and also, no doubt, to lower temperature of the fruit on route made possibly by the use of refrigeration. With similar conditions as to transportation the disease would be of no more importance here than it is there. There seems little prospect that fruit will soon be sent from Porto Rico under better conditions as to temperature. However it is possible as first suggested, I believe, by Mr. C. W. Mann, to ship the oranges as soon after picking as convenient. Prompt shipment may have disadvantages but it can not but lessen to some extent the amount of decay at the

time of marketing. In the samples studied the percentage of decay was closed to ten per cent each week. My work also enables me to corroborate Mr. Mann's statement that the problem is one of the groove rather than the packing house.

"In brief, the fruit is infected in the groves. To reduce the source of infection the pruning out and destruction of the dead or unhealthy branches bearing the spores of the rot fungus is recommended, and spraying the trees with fungicides. Although work with this subject is being continued it is improbable that any reason will be found for recommending anything other than these already familiar and common means of fighting disease in the groves."

[fol. 506] PLAINTIFFS' EXHIBIT NO. 30

Proceedings of the Twenty-eight Annual Meeting of the Florida State Horticultural Society, Held at Tampa, Fla., April 13, 14, 15, 16, 1915

Compiled by the Secretary, Published by the Society

boxes being nailed together by a nailing machine operated by a boy. This machine has been one of our most satisfactory economies.

The placing of fruit in boxes is done under the watchful eye of a packing foreman and any attempt to "slip bad workmanship over on him" would be a thing of short duration to say the least.

No detail of the work is more carefully performed than the making out of loading manifest, in order that each manifest may be a true exhibit of the various brands and sizes contained in the car. A duplicate manifest is placed in all cars for the convenience and information of receiver at destination.

All cars are skilfully loaded and stayed to insure the best possible delivery.

This completes our preparation of the fruit for the market, experts having directed and watched every step of its progress from tree to the car. We now turn it over to expert salesmen to get the most they can for it.

[fol. 507] Dr. O. W. Sadler, Mt. Dora, Fla.

Mr. President, Ladies and Gentlemen: Regarding many of the points in the packing and shipping of citrus fruits, it is now unnecessary to dwell upon details.

After five years of experimentation by government experts, and enthusiastic practical experience instigated by the Florida Citrus Exchange, there is no longer need of detailed argument that all fruit should be gathered with the gloved hand, and cut by a clipper that insures short stems and no clipper cuts. Each fruit should be removed from the limb to a thick canvas bag, by the hand, the bag not to hold over one-half over one-half box. The bag should open at the bottom, so that the fruit may be placed in the box without appreciable dropping.

The size of field boxes still varies in practice—some using those holding one-half box, two to count as one, others a full box, both intended to average a packed box.

The average class of packers we are compelled to employ, prefer the full sized box. When using any other size, one would think they all "came from Missouri," as it takes a great deal of "showing" to make them believe they are not picking too much, when using two smaller boxes for one box.

Hauling

When two men are employed loading in the field, there is one point in favor of the "whole box" standard, there is but half as many chances of bruising the fruit from over filling. And another, that the large box gives a smaller bulk on the wagon than the smaller boxes. The same careful handling to avoid bruising fruit, is necessary in either case.

[fol. 508] In the Packing-house

All "Exchange idea" packing houses are fitted up with machinery for handling the fruit with the least possible injury, and should be carefully watched, that no loose parts, slivers, or projecting nails shall bruise any part of the rind, and that it all be arranged so that fruit can not "drop," but must "roll" from start to finish.

Washing and Drying

It is as yet absolutely necessary to wash fruit to give it the satisfactory appearance to please the trade.

During the early experience in washing, it came to be believed that "washing" greatly increased the decay of fruit. With the careful packing and handling of fruit, and the great improvements in washing machinery, the supposed bad effects of washing have mostly disappeared.

The best outfits for washing, now consist of a soaking tank filled with hot water, containing an alkaline cleansing powder, especially where the fruit is black from sooty mold from the whitefly. Gold Dust or other alkaline powders are now used in the water.

The Proper Drying of Fruit

The next and most important step, is the proper drying of the fruit before it is wrapped and put into the box.

Two methods are employed for drying, involving two diametrically opposed principles—the absorption of moisture on the fruit, by cold air, the other by hot air.

Those using "cold air" seem to be prepossessed by the "precooling idea" as practiced in California, where they go still further, by precooling the fruit in precooled rooms, and load into precooled cars, and the cars iced sufficiently to maintain 37 to 40 degrees.

[fol. 509] Those trying to dry by cold air blast in Florida, seem to forget the immense difference in climatic difference in the atmosphere in California, which gives them only eleven to fourteen inches of rainfall, and that of Florida, which gives from 53 to 56 inches of rainfall. They also forget that the California fruit travels to market over a dry, hot desert for over one thousand miles, where dryness is not a question, but where heat becomes their greatest foe, and naturally, and in consonance with the law of physics, suggests cold.

They who try to dry by the cold blast, also utterly forget the natural law of physics—that cold tends to precipitate moisture—that when the "dew point" is reached, water actually deposits on all objects down to the dew point temperature.

Two marked practical demonstrations of this point have come in my experience.

Several years ago, my wife in my absence, had about one hundred boxes of oranges packed on a clear cool day and

left in the packing house. During the night the weather changed to a warmy, muggy atmosphere. When she went to the packing house in the morning to continue packing, she found the paper and fruit throughout the packed boxes, as wet as though it had been given a Russian steam bath. It was put out in the sun, and dried as well as such could, and shipped to Baltimore. The returns were—"Received in very bad order"—for which $1.00 per box was taken from the market price. This is a strong physical, as well as financial demonstration of precooled fruit attracting moisture in Florida.

Another demonstration was observed the 29th of December last. The previous day and night had been clear, cold and dry. In the morning it warmed up rapidly, and al- [fol. 510] though the day was bright and clear, every casing and piece of woodwork inside the house was covered with moisture in drops, turning the varnish bluish as you have all noticed under such conditions. The metal safe was so thoroughly wet that it dripped a puddle in the floor, and the paper on the walls was thoroughly wet.

A box of oranges I had packed the night before, and left under cover, I found with the papers as wet as if I had thrown a pail of water into the box.

A still more practical demonstration under up-to-date packing house conditions, I will now give you.

During a cold, damp morning in March, later raining, the Mt. Dora house was packing fruit with the cold air system, the fruit going to the bins glistening with moisture in every pore of the rind. The manager and myself drove over to Tavares, where they were drying by means of hot air, produced by radiation from twelve one-inch pipes, close up under the rolls that carried the fruit, extending lengthwise of the 36-feet-long dry box, all encased in a box made of flooring, the pipes being supplied by steam from a 10 H. P. boiler at 40 lbs. pressure. The fruit came through as dry as though it had been in the sun on one of our hottest and dryest days.

It is an axiom—The hotter the air, the more moisture will it absorb. The colder the air, the more moisture will it deposit. Hence the absurdity of trying to absorb moisture from fruit by a blast of air that is already loaded with nearly or quite all the moisture it can hold.

We have tried two years of the cold air blast at the Tavares house, by all the methods known at the time, and gave it up as a failure.

[fol. 511] Two years ago we installed a hot water soaking tank, and radiated steam heat by a system of one-inch pipes the full length—36 ft., by 4 ft. wide, close under the rolls, with a small fan at the distal end, drawing the air through the main dry box, and blowing it back through the drip rack box by its side. The drip rack is also enclosed and supplied by a system of pipes that can be used when necessary. It has never proved necessary to turn the steam into the pipes in the drip rack, except on very cold, damp days.

The 10 horse boiler with 40 lbs. of steam, heats the water in the soak tank and maintains 90 to 100 degrees temperature in the drying box. Any desirable heat can be maintained.

The fruit is in the drying box about eight minutes, and emerges thoroughly dry. A thermometer thrust to the center of a 150 size orange, reads 96 degrees Fahrenheit. The water in the soak tank is maintained at 102 to 130 degrees, according to how black and sooty it is. There is no danger from heat of the water, as long as you can barely endure the hand in the water.

The greatest objection to the installation of the hot air drying, was the fear of cooking the fruit. Experience and actual thermometrical tests show how absurd was that fear.

I must call your attention to another point of great value in favor of hot air drying; that is, its aid in preventing decay.

Slight injuries that pass observation, are well dried out,

Blue mold decay, can only take place in the presence of moisture. This has been fully demonstrated by experi-

[fol. 512] ments of the Government experts in actual tests: Therefore; bruises that are thoroughly dried cannot decay from "blue mold," unless the spores have been forced deep into the rind in the presence of constant moisture.

Ladies and gentlemen, I acknowledge that "Hot Air" is my hobby—to dry oranges in—yes, to live in. I can fully sympathize with the Esquimo, to whom cold is Hell, and heat is Heaven.

The reported opinion of the worthy business manager of the Exchange to the contrary notwithstanding, who ad-

vises through the "Grower," all new packing houses to put in the cold air process.

We of the Lake Region Packing Association, at Tavares, after two seasons of the most absolute satisfaction with hot air, beg to differ and say, don't!

Our manager, Mr. J. B. Booth, will take great pains and pride in showing any one interested all the details of our system, its advantages, cheapness of installation, cheapness of maintenance, etc., and while in operation its absolutely satisfactory workings. In this matter we have no "axe to grind," or financial interest in marketing any part of it. We only urge its principles for the benefit of all growers, after extensive demonstration. Come see us and "be shown."

Packing

From the frequent returns of inspectors at the marketing end, "slack," or "flat pack," it is evident it is no careless job to pack fruit so firm that the box is as full at the market end as when it was first put in. It is evident that it requires the constant application of force to place every orange firmly in its place, and that the sizer shall be so exactly adjusted that the average in each bin shall fill the box firmly.

[fol. 513] As I go through packing houses, I see some packers laying their oranges in gently, and when the box is finished, it is piled high, depending on the foot press to push them down so the top can be nailed on. Others place each orange firmly in place, and when their box is done, the press only has to firm the top down to its bulged form, and the middle front is held as firmly as the ends. I then ask myself, how it is possible for the soft pack and the firm pack to give the same desired effect; the answer is, they can't. My opinion is that the loosely laid in fruit is the cause of the frequent complaint, "flat pack."

To Twist—or Wad

I believe that a single twist, or sufficient to cause the wrap to stay in place, especially on the top layer, is necessary.

Placing all brand printing on wraps in the same direction on top layer gives the most pleasing effect to the pack.

Regarding the Sizes to Make

My attention has been called to the sales returns on account of size. Out of a considerable number of sales returns, I have been shown that 216's often brought 10 to 25 cents per box less than either 200's or 250's. I have never heard of a reason for the 216 pack, except that it was an easy pack. If it is true that 216's average less than 200's and 250's, why should we continue to pack that size, when the large ones of the 216 pack will pack in 200's and the smaller in 250's—and bring more money?

The Size of the Box

The size of the box has become practically standardized in that of two sections of one cubic foot each. Does the [fol. 514] present marketing customs call for, or admit of a change for the obtaining of a better price?

Our deceased fellow member, Mr. Dudley Adams, of Mt. Dora, used to pack his fancy fruit in three sections, instead of two, as we do tangerines, and had the reputation of securing from one half to one dollar above the market price of standard boxes. Schrader & Co. are trying out the introduction of half bushel boxes.

Our parcel post regulations will undoubtedly afford an outlet for fancy fruit in packages of one to four dozen, within the near zones, and enlarge the mail order business.

The packing of fruit in central packing houses at some large sales center, or at the more northerly diverting points, has been under consideration by some of our leading thinkers, and now that the new railroad rates on "bulk shipments" tend to make such a method practicable, it is worth investigation.

A bulk shipment and northern central packing house would have these advantages: Cheaper freight rates, more and cheaper labor in packing house, absolutely sound fruit to buyers, a larger F. O. B. market, and a better market for culls, and a better opportunity to sell small lots direct to consumers, or the retail trade, all of which seems to me to be worthy of the most careful consideration.

Changes in Box to Meet Another New Marketing Feature That Has Developed Within the Last Year or Two. The organization of consumers' buying clubs throughout the north is in practice, and might be encouraged and assisted by our selling organization of the exchange, and thus get [fol. 515] closer in touch with the consumer—the end most desired.

Direct from Grower to Consumer. The express companies are succeeding in this method, why not the growers, through the Florida Citrus Exchange selling force?

After five years of insistent, persistent preaching and teaching of "The Exchange Way" of packing, and the very general practice of associations in securing a perfect pack, let every grower back up every packing house manager in maintaining as perfect a pack as possible. We all know how easy it is to "slack up" from the best both physically and morally. Don't.

Can We Lessen the Expense? Now that we know how to pick, handle, and pack fruit in a way to secure its sound and presentable delivery to the consumer, can we lessen the expense of so doing?

I naturally expected that by the use of machinery and systematized methods of handling fruit we would be able to do it cheaper as well as better than in the past; but instead, expenses have actually increased.

Now let me ask every grower, and especially every packing house manager, at the end of this season, to go over every detail of the business, and see if it is not possible to cut out a little expense here and a little there, and before the next season opens, call a meeting of packing house managers in each sub-exchange or district, and all others interested, collaborate all suggestions advanced, and adopt a uniform system of packing, and packing house work, and prices, and so increase the advantages of co-operation. The success of orange raising is going to depend upon the "survival of the fittest."

[fol. 516] Distribution of Fruit to the Consumer

E. Stuart Hubbard, Arlington, N. Y.

Mr. President, Ladies and Gentlemen: There has been a good deal of agitation in the press lately regarding the final

method of distributing fruit to the consumer. There have been a good many claims made that the present manner of distribution is wrong and that it is a great deal more expensive than it should be; that is, the consumer has to pay a great deal more in proportion to what the grower receives, than he should. There have been statements made in the papers which are very misleading, often false, with regard to the prices which the consumer has to pay. For instance, with regard to oranges, in one of our late papers there was a statement made by a California grower that was something like this, as I recall it, that eighteen cars of California oranges had been sold on two successive days in New York market at auction at an average of $1.80 per box, and that those same oranges, would cost the consumer an average of something like $4.50 per box; making $2.70 profit to the brokers and retailers. A statement like that is an absolute falsehood.

There is a small proportion of trade in New York or any of the large cities which pays a high price for oranges; this trade is supplied by the best oranges which reach the market. These prices are above the average of the sales. If you will look at your auction sales for any one day, you will find there are a few boxes which sell for much higher prices than the average. There are a few boxes of large sizes, like 126's or 150's of the best brands, which will sometimes sell for $2.00 or $3.00 a box more than the average prices. [fol. 517] The man who usually writes these articles is often an expert who is given the position of investigating, and he goes to the stores where this fine fruit is sold at high prices, buys fruit there, and goes back and writes these figures as his basis.

In the meantime, the great mass of fruit, good average fruit, is bought by the middle classes and the lower classes at very much cheaper prices.

I am primarily an apple orchardist, and while I have been brought up in Florida, and have grown and shipped oranges, I am now raising apples with my uncle in New York State. We have not been satisfied with the methods of selling fruit through commission men, and we have lately been selling it ourselves to the retailers. In that way, we have been try-

PLAINTIFFS' EXHIBIT No. 31

United States Department of Agriculture, Bureau of Plant Industry, Horticultural & Pomological Investigations, Washington, D. C.

The Relation of Washing to Decay in Washington Navel Oranges

Season of 1914-15

Introduction

During the past two or three years there has been a great increase in the washing of oranges in the packing houses of Southern California, and the indications are that a much larger proportion of the fruit will be subjected to this [fol. 518] treatment in the future unless effective measures can be used for the control of scale and sooty mold in the orchards.

The results of the investigations of the Bureau of Plant Industry have shown that washing, even under the most favorable conditions, is followed by an increase in the decay in the packed fruit. The process offers ideal conditions for the infection of injured fruits with blue mold, and where washing is employed a higher standard of care in the field and house-handling methods becomes imperative in order to reduce the chances of mechanical injuries in the fruit to a minimum. The packing of moist or wet fruit provides conditions that are very favorable for the development of decay in injured fruit.

During the orage shipping season of 1914-15, an investigation was conducted by the Bureau to determine the relation of handling to the occurrence of decay resulting from the methods used in the washing and subsequent drying of the fruit. The work was undertaken at the request of the Citrus Protective League and packing house experiments were made in ten different houses during the season.

Orange Washing and Drying Experiments

The handling experiments were planned to make a direct comparison of fruit very carefully picked by the bureau men with the same kind of fruit handled under ordinary

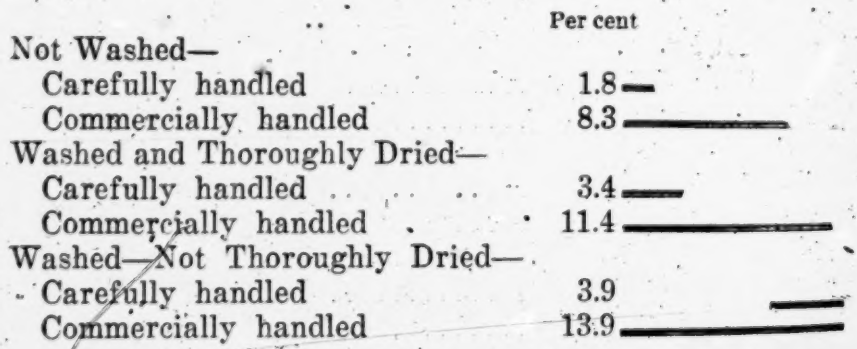
commercial conditions. The fruit was packed and held in the packing houses and the percentages of decay in the various lots were determined by inspection at the end of two weeks. The different lots included carefully handled and commercially handled fruit washed in the ordinary machinery, part of which was packed while still moist or [fol. 519] wet and an equal amount of fruit which was thoroughly dried before packing. Part of the same fruit was packed without washing or brushing. These experiments were designed to show the effect of the washing process on the keeping quality of the fruit and to furnish data indicating the percentages of the decay due to the wet or moist condition of the fruit at the time of packing.

The results of these tests are given in Table I and the accompanying diagram—Figure 1.

Table I.—Average Percentages of Decay in Carefully Handled and Ordinary Commercially Handled Washington Navel Oranges—1915

Number of experiments	Treatment	Carefully handled	Commercially handled
		Per cent	Per cent
	Not brushed or washed	1.8	8.3
23	Washed and thoroughly dried	3.4	11.4
	Washed and not thoroughly dried	3.9	13.9

Figure 1.—Diagram Showing Percentages of Decay in Table 1



The data show that the percentages of decay in carefully handled fruit was increased from 1.8 per cent in the un-

washed fruit to 3.4 per cent in the washed and thoroughly dried fruit and was increased to 3.9 per cent in washed [fol. 520] fruit packed wet. In the ordinary commercially handled lots the average percentage of decay in the unwashed fruit was 8.3 per cent. Washing followed by thorough drying increased the decay to 11.4 per cent, and in the same fruit packed wet the average decay was 13.9 per cent. The difference in the percentages of decay developing in the wet and dry-packed fruit was considerably greater during the period of cloudy or wet weather early in the season. The figures given are the averages for the whole season.

Relation of Handling to Decay in Washed Fruit

The results indicate that the losses from decay resulting from packing improperly dried oranges are directly in proportion to the care exercised in the methods of handling. Fruit showing a high percentage of mechanical injuries develops the maximum amount of decay following washing without thorough drying. In the fruit that was picked with sufficient care to avoid serious injuries there was a comparatively small increase in the decay in the lots that were washed and not thoroughly dried before packing. It is probable that a greater difference in favor of very thorough drying would have been shown if more efficient methods of handling the specially dried lots had been available during the early part of the season.

Methods of Drying Oranges

By heating the air blast used in orange dryers the relative humidity of the air is lowered, which increases its capacity for absorbing the moisture on the surface of the fruit. Experiments were made to determine the time re- [fol. 521] quired to dry the fruit under different conditions of temperature and humidity. The humidity of the air was varied by the use of a heating apparatus and by passing the air through a compartment containing calcium chloride. The results of these experiments showing the time required to dry oranges under different conditions of humidity and temperature of the air blast are given in Table II.

Table II.—Relation of Temperature and Humidity of the Air in Promoting the Rapid Drying of Oranges

Temperature of air blast	Relative humidity of air blast	Time required for complete drying of oranges
55 Degrees F.	70 per cent	11.0 Minutes
55 " "	a 57 " "	6.5 "
68 " "	a 40 " "	4.0 "
76 " "	b 30 " "	2.5 "
82 " "	b 22 " "	2.0 "
82 " "	74 " "	9.5 "
101 " "	c 57 " "	4.0 "
103 " "	b 18 " "	1.7 "
130 " "	c 14 " "	1.2 "

Note

a—Calcium chloride used.
b—Calcium chloride and heat used.
c—Heat used.

The most rapid evaporation of the moisture on the fruit took place with dry air at a temperature of 130 degrees F. The time varied from approximately 11 minutes with an air blast having a temperature of 55 degrees and a relative humidity of 70 per cent to about one minute with air at a temperature of 130 degrees and 14 per cent humidity. The bearing of the data presented in Table 2 on the methods of [fol. 522] drying oranges under commercial conditions is shown by the considerable reduction in the time required for effective results when a dry air blast is used. The use of Calcium chloride in conditioning the air has not yet been demonstrated to be as effective or practicable for this purpose as heat. The temperature of the fruit was not increased materially after two minutes in an air blast at a temperature of 130 degrees.

Experiments were conducted with two different types of dryers. In one of these the roller conveyor was used and the air blast was forced through narrow openings above the fruit which extended across the conveyor parallel to the rollers. The openings were formed by air nozzles about three inches wide, the air apertures being about one-quarter of an inch in width. In the other device a rope

conveyor was used and the fruit passed through narrow trough-shaped runs, the air blast being forced on the fruit from the sides and bottom of the runs.

In the experiments conducted with the dryers it was found that infection with blue mold may be increased if the duty air of the packing house is blown on the fruit in the air blast. In an efficient system of drying the cost of heating the air to a temperature of 130 degrees should not exceed one dollar per car of packed fruit.

This Circular is issued in order to present the results of the investigations promptly at the close of the season's work. The co-operation of the citrus associations and particularly the Pomona Fruit Growers' Exchange was given to the Bureau Investigators throughout the work. In addition the California Fruit Growers' Exchange and the Citrus Protective League shared the expense of conducting [fols. 523 & 524] the investigation with the Bureau of Plant Industry.

C. W. Mann, Pomologist, Fruit Handling and storage Investigations.

[fol. 525] PLAINTIFFS' EXHIBIT No. 32

Reprint, April, 1922

United States Department of Agriculture

Farmers' Bulletin

Washington, D. C. 696. November 10, 1915

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief

Handling and Shipping Citrus Fruits in the Gulf States

By H. J. Ramsey, Pomologist in Charge of Fruit Handling and Storage Investigations

---

	Page
Introduction	525
Causes of decay in transit	526

Page
Prevention of losses due to decay 527
What careful handling means 528
Harvesting, packing, and shipping operations 529
Field handling 530
Packing-house handling 535
Methods of shipment 547
Refrigeration 548
Precooling 549
Cold storage 551

Introduction

The object of commercial fruit growing is profit. Even though a grower is successful in securing satisfactory yields of high-quality fruit, it does not necessarily mean that the business of fruit growing is a success financially. The primary object of commercial fruit growing can not be attained unless the crop can be disposed of profitably. Too many fail to realize that under modern conditions of handling, of long-distance shipment, and of marketing a perishable commodity such as citrus fruits, the growing of fruit is one thing and the marketing of it necessarily entirely another. Few growers possess the wide perspective or experience or can individually afford to obtain the information necessary to market their fruit to best advantage. The distribution and selling can be more successfully handled by thoroughly trained men and organizations devoting their entire time and effort to the disposal of such crops.

No attempt will here be made to discuss systems of marketing, or the marketing question in the usually accepted sense, but rather to point out some of the factors governing the merchantable condition of fruit, particularly the re- [fol. 526] lationship of harvesting and handling methods to losses from decay in transportation and at the market.

Soundness and good keeping quality are of fundamental importance in the successful disposal of a perishable fruit crop. No system of marketing can procure for the grower the highest market price for his product unless it is delivered in sound condition, so that it will remain in good merchantable condition for a sufficient time to allow for proper distribution to the consumers. If the grower can not de-

liver his fruit at the market in good, sound, attractive condition, the money and labor invested in his orchard enterprise are largely, if not wholly, wasted.

Causes of Decay in Transit

The losses from the decay of citrus fruits in transit and on the market are due primarily to fungi, which attack and cause decay or rotting of the fruit. Broadly and generally speaking, these fungi may be divided into two classes, parasitic and saprophytic. Parasitic fungi have the power to attack and cause decay in sound, uninjured fruit, saprophytic fungi usually can gain entrance and cause decay only through injuries, mechanical abrasions, or breaks in the skin or the cells composing it. It is safe to say that more than 95 per cent of the decay of citrus fruits occurring on arrival at the market and during the first ten days after arrival are due to attacks of fungi gaining entrance only through injuries of some kind. Blue mold is practically the only fungus of this type causing decay in oranges, grapefruit, lemons, and other citrus fruits in transportation and on the market. The losses from blue-mold decay, however, are oftentimes very serious and frequently the sole reason for low prices, demoralized markets, and losses instead of profits to the grower. There is not only the direct loss of fruit through decay, but the indirect losses due (1) to depreciation in prices for fruit actually sound, (2) to a reputation for poor keeping quality, and (3) to the proportionally high overhead expense of handling a perishable product which develops great waste and spoilage in tarnsit and after arrival at the market.

The decay of citrus fruits from the Gulf States caused by parasitic fungi is usually not very serious, especially in transit and for the first week after arrival at the market. The most serious losses from this cause are due to attacks of fungi causing the type of decay commonly known as stem-end rot. Usually no stem-end decay is found on the arrival of the fruit in the market, nor does much of it develop under ordinary conditions during the first week after arrival. The losses from this decay are the most severe following a holding period of ten days or two weeks. This disease varies in severity with seasons and also with periods during any one shipping season. Climatic and temperature con-

[fol. 527] ditions are very important factors governing the development of this disease both in the orchard and after the removal of the fruit from the tree, the losses being usually much heavier in the orchard than in transportation. If affected fruit could be successfully culled out at the time of picking and packing, stem-end rot would be a negligible factor in the marketing of the citrus crop, at least as far as the fruit actually shipped is concerned. The impossibility of grading out the affected fruit except such specimens as actually show decay from this cause makes it frequently an important factor in determining the keeping quality of the fruit on the market.

Diplodia rot is oftentimes associated with stem-end decay and during some seasons may be very serious. It closely resembles stem-end decay due to Phomopsis, and in the earlier stages is indistinguishable from it. For this reason it is also commonly referred to as stem-end rot. In Porto Rico and Cuba this Diplodio rot, next to blue mold, is one of the most serious causes of decay of citrus fruits in transit and on the market.

Colletotrichum, or anthracnose, sometimes causes some decay in both oranges and grapefruit on the market, especially if these fruits are held for a long time under ordinary warehouse conditions or in cold-storage temperatures. In the handling of citrus fruits through the usual channels this disease is ordinarily not of importance.[1]

Prevention of Losses Due to Decay

Obviously, the prevention of losses due to stem-end decay and diseases of a similar nature must depend on proper orchard, cultural, and sanitation practices, at least in so far as such practices can be depended upon to control or

---

[1]Discussion and description of the diseases mentioned as sometimes being the cause of decay of citrus fruits in transit and after arrival at the market may be found in the following publications of the Florida Agricultural Experiment Station: Bulletin 53, "Some Citrus Troubles," by H. H. Hume; Bulletin 107, "Stem-end Rot of Citrus Fruits," by H. S. Fawcett; Bulletin 108, "Diseases of Citrus Fruits," by P. H. Rolfs and others; Bulletin 111, "Melanose and Stem-End Rot," by Floyd and Stevens.

lessen the severity of attacks in the orchard. As stem-end rot develops very slowly in temperatures below 45° to 50° F., the liability to serious losses can be minimized by prompt cooling, the transporting of the fruit under low temperatures, and the holding of it on the market so far as praticable under low temperatures.

By far the most serious losses, as already pointed out, are due to blue mold, a fungus that gains entrance to and causes decay of citrus fruits only through injuries and breaks in the skin. Extensive investigations and practical commercial experience have conclusively demonstrated that citrus fruits can be handled with sufficient care to prevent these injuries and to deliver the fruit on the market in sound condition, even under adverse climatic surroundings (fig. 1). [fol. 528] It has been conclusively shown that in so far as good, sound, merchantable condition is concerned the responsibility rests primarily with the grower and the shipper. The care exercised in preparing the fruit for market determines to the greatest degree its condition on arrival and its keeping quality while being held for distribution to the consumer. Keeping clearly in mind the importance of sound fruit on the market and the responsibility of growers and shippers for the condition of fruit on arrival and while being held on the market, one can not but be impressed with the fact that the grower himself largely determines the relative market price of his fruit. The matter of proper handling is an economic problem of greatest importance, a probelm of thorough organization and of human efficiency. The success or failure of the orchard enterprise often depends on this factor alone. Certainly no grower can hope to obtain the fullest measure of success without the strictest attention to methods of handling and harvesting in preparing his fruit for market.

What Careful Handling Means

Many growers realize, at least to some extent, the importance of and necessity for careful handling, but often-

[1] For a report upon these investigations, see U. S. Department of Agriculture Bulletin No. 63, entitled "Factors Governing the Successful Shipment of Oranges from Florida," 1914.

times have no clear idea of what careful handling means or the seriousness of the slightest injury to the fruit. The elimination of losses due to blue-mold decay is not a matter [fol. 529] of attention to one or a few details of the handling problem, but of exercising the utmost care consistent with commercial work in all operations of picking, hauling, washing, drying, and packing, to prevent injuries, however slight. It necessitates thorough organization of labor and the most careful inspection of work, both in the field and

Fig. 1.—Oranges used in the Florida shipping experiments in 1911, showing the condition of the fruit on arrival at the market. This shipment was made during a period of very unfavorable climatic conditions. Blue-mold decay developed as follows (from left to right): Careful pick and pack, 4 per cent; commercial pick and careful pack, 35.6 per cent; commercial pick and pack, 68.1 per cent.

at the packing house. With a view to more clearly emphasizing what constitutes careful handling practice, the various harvesting operations will be discussed separately. The recommenadtions and directions given are based not only on extensive investigational work, but on results of the most successful commercial practice in the practical handling of citrus fruits for shipment.

Harvesting, Packing, and Shipping Operations

The operations of harvesting and preparing citrus fruit for market may be divided into two parts—field handling and packing-house handling. The former includes all the operations of picking, hauling, and delivery of the fruit to the packing house; the latter the operations of cleaning, grading, sizing, packing, and loading. In picking citrus fruits for shipment it is necessary to sever the fruit from the trees by means of clippers (fig. 2). After the fruit is

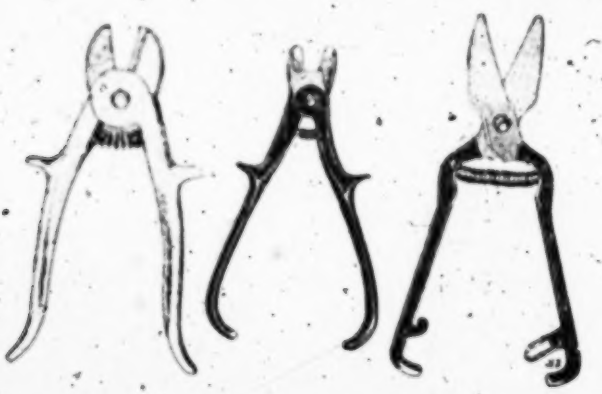


FIG. 2.—Three types of clippers used in picking citrus fruits

clipped it is placed in a picking bag or basket, from which it is emptied or transferred to the field box. Much of the fruit in most of the citrus sections, of Florida at least, can not be reached from the ground or from ordinary stepladders, and long ladders placed against the trees are used. The fruit in the field boxes into which it is emptied after being picked is hauled to the packing house on wagons equipped with springs. In the packing house, fruit that is affected with sooty mold, or otherwise is need of cleaning, is either run through dry brushers or through washing machines; thence on to drying racks or through driers to the grading belts. After being graded it is sorted by means of mechanical sizers, each size being run into separate bins for packing. The fruit is then wrapped and packed, according to diagrammatic arrangement, in boxes, and after the covers are nailed on it is ready for loading and shipment.

[fol. 530] Field Handling

Origin of Injuries

One of the most common as well as most serious types of injuries made in picking is what is known as "clipper cutting." In severing the fruit from the branch the skin is often cut or punctured with the points of the clippers. Oftentimes, in clipping, the clippers leave a long sharp stem on the fruit, and while a long stem does not cause the decay or injury of the fruit to which it is attached, it is as serious as clipper cuts, if not more dangerous than they. A long, sharp, and jagged stem projecting from an orange may injure all the fruit with which it comes in contact in the picking bag, field box, brusher, washing machine, drying rack, packing bin, and the packed box. Long stems are among the most common as well as most serious imperfections in picking.

Considerable injury may also result from pulling fruit that can not be easily reached for clipping and from shaking the fruit so that it falls to the ground before placing it in the packing boxes. Injuries from thorn punctures frequently result either from high winds before the fruit is picked or through the carelessness of the pickers in handling the ladders or in transferring the fruit to the picking bag. Serious losses and decay result from injuries made by dropping instead of placing the fruit in the picking bag or basket, or, worse yet, by shooting it in; by cutting or scratching the fruit with the finger nails; by squeezing it against the picking ladder while in the picking sack; by carelessly emptying or pouring it into the field box; and by sand, gravel, splinters, protruding nails, etc., in the field boxes. In hauling, additional injury may result from putting too much fruit into the field box, from heaping it so that, in loading and stacking, the boxes rest on the fruit in the box below, and from the hauling of fruit on springless wagons over rough roads.

In the packing house the fruit is subject to injury in numerous ways in the course of the various operations of cleaning, drying, grading, sizing, and packing. The amount of injury inflicted in the packing house will depend both upon the care exercised by the workers and upon the arrangement, character, and state of repair of the packing

house machinery and equipment. The most common causes of injury are rough, careless handling by the workers; poor arrangement of machinery; undesirable types of washing machinery or machines carelessly operated; badly constructed drying racks or inefficient driers, steep gravity inclines or drops; scratches by finger nails in grading and packing; and lack of proper care in packing, nailing, and loading, either in handling fruits individually or in the packing box. The washing of fruit in dirty, infected water and slow or but partial drying serve to infect with the blue-[fol. 531] mold fungus every scratch or injury made either in the field or packing house and to provide ideal conditions for its germination and growth.

Picking

Unless the fruit is properly handled in the field at the time of picking, the care exercised in the handling of the fruit in the packing house and the provision of machinery and equipment especially designed to handle the fruit both economically and carefully are largely wasted. The injurious results of bad field handling can not be counteracted or atoned for by providing either the best equipment in the packing house or by exercising the greatest care in packing-house handling.

The amount of injury made in picking depends primarily on the picker and the equipment provided. In order to secure the desired results, the pickers must have a proper appreciation of and know what careful handling means and be supplied with the best tools and equipment obtainable. Given, however, the best of equipment, the care exercised by each picker in all the different operations of picking is the big determining factor. A careless workman will do poor work no matter what his equipment.

All pickers should wear gloves, to guard against finger-nail scratches, and the clippers should be sharp and properly set or adjusted, so as not to leave any ragged fragments in clipping. The points should be dull or rounded, in order to guard against cutting the skin of the fruit when bringing the clipper in position to sever the fruit from the branch. There are on the market several makes of clippers so constructed that while clipper cutting is not impossible,

the chances for injury in this way are greatly minimized. In order to do the work properly, especially where the picker must reach some distance for the fruit, the stems should first be cut long and a second cut be made when the fruit is brought to a position where the picker can easily see what he is doing. This method of clipping removes any and all excuse for clipper cutting or the leaving of long stems. While this double cut may take a little longer, practice soon enables a picker to accomplish as much in this way as the other, if quality of work is given equal consideration with quality.

After the fruit is properly clipped, that is, after the stem is cut off clean and close to the fruit in such a way as not to leave a part protruding, to cut or injure other fruits, it should be placed in the picking bag by hand, not dropped or throwing in, as is too ferquently done. The dropping or throwing of the fruit into the picking bag or basket and into the field box is one of the most common and serious causes of injury and resultant decay in transit.

A heavy canvas bag carried from the shoulder by means of a strap and holding not more than half a field box is to be preferred as a picking receptacle. This bag should be [fol. 532] partly closed at the top, making it necessary to place the fruit in the bag by hand, and the bottom should be open but folded up on the side and fastened by hooks or ropes near the top, so as to make a sack or bag. In transferring the fruit to the field box, the whole bag is lowered into the box and the fastening and fold loosened; after which the bag is drawn upward and away, allowing the fruit to roll gently and easily into the field box (fig. 3). This type of bag is preferable to the bushel basket or wicker basket frequently used and to other picking receptacles from which the fruit has to be poured or emptied through the same opening used in picking. With the wicker basket there is a tendency to shoot or drop the fruit into it in picking and to pour the fruit into the field box rather roughly or carelessly in emptying. Good work undoubtedly can be done even with a basket, but it offers too many inducements for carelessness. The things to guard against in using the picking bag are the danger of bruising the fruit between the ladder and the picker's body and the possibility of thorn punctures through the canvas. If good

heavy canvas is used, there is not much risk of the puncturing. Great care should be exercised in handling and setting the ladders, in order to avoid bruising the fruit against the ladder or limbs or scratching it on branches or thorns. Where stepladders can be used, they are preferable, but most of the older orange and grapefruit trees in Florida are too high and large for this type of ladder.

FIG. 3.—Transferring oranges from a picking bag to a field box

Use of the Field Box

The field box in common use in most of the citrus sections of Florida holds approximately one packed box of fruit. It is usually about 28 inches long, 12 inches wide, 13 inches deep, and may or may not have a central upright partition (fig. 3). A common source of injury in field and packing-house handling is the poor condition of the field box. Every box sent into the orchard or grove should be thoroughly inspected, kept in good repair, and free from protruding nails, splinters, gravel, and twigs. A box entirely boarded over on the bottom is preferable, as this prevents injury by

[fol. 533] stems of weeds and other objects that might otherwise extend into the box and injure the fruit. The boxes should not be filled or heaped to such an extent that any fruit will rise above the end pieces, as where it does the boxes when stacked will rest on the fruit instead of on the ends of the boxes themselves.

This type of field box came into general use through the practice of buying large quantities of fruit on the trees at a fixed price per box. Originally this price was intended to be per packed box, but since it is more convenient to keep the record of the fruit as it leaves the grove, this type of field box, which holds enough fruit to allow culling and still give the buyer a packed box of oranges, was developed. This field box, from the standpoint of careful handling, is not an ideal one by any means. It is too heavy to be handled by one man as carefully as it should be in loading and unloading. In the handling of boxes of this weight and size, they are frequently dropped or set down violently either on the wagon or when unloading in the packing house. A box made of lighter material and holding somewhat less fruit could be handled by one man with much greater ease and care. It is also a question whether a smaller, lighter box would not withstand to a greater degree the "bucking," as it is usually termed, when unloading the empty boxes in the field. The breakage and bad repair of field boxes are due largely to rough, careless handling in disposing of them after emptying or in distributing them in the orchard, where they are often thrown violently and carelessly from the wagon into piles on the ground. Due care should be used in handling the boxes when filled, in order not to injure the fruit in them, but equal care is required in the handling of the field equipment when empty, in order to guard against breakage, splintering, etc.

Hauling

The wagons on which the fruit is hauled should always be provided with good springs, and no fruit, under any circumstances, should be hauled on springless wagons, no matter how good the roads may be. The driver should be provided with a special seat, leaving him no excuse for riding on top of the load or on the fruit itself. The field boxes

should be properly loaded and stacked, and if necessary the load should be thoroughly roped to prevent the shifting of the boxes, and the utmost care should be used both in loading and unloading to guard against unnecessary jolting or rough handling. Where boxes of the heavier types are used, it is not an infrequent occurrence to see them set down or dropped with such force as to cause considerable fruit to bound out on the floor of the packing house. Care in handling the fruit both in the field and packing house is oftentimes largely nullified by careless, rough handling in hauling and unloading.

[fol. 534] Supervision and Payment of Picking Crews

Where the picking is done by picking crews hired by the grower, shipper, or marketing organization, a good reliable foreman should be secured, and it should be the duty of this foreman to see that all pickers do their work carefully and properly, that the clippers are in good condition, that the picking boxes are in good repair, and generally to supervise the quality of work in field handling. In order that he may know just what kind of work his pickers are doing, he should make frequent inspections of each man's work, ascertaining by actual count his percentage of clipper cuts, long stems, and other injuries and imperfections. These duties, if properly and conscientiously performed, will require all his time; and in most cases he should not be required to do any picking. The payment of pickers by the day, instead of by the box, is preferable from the standpoint of securing careful and proper work, as box or piece labor usually puts a premium on quantity primarily. Careful inspection of the character of work secured under the two systems of labor payment has conclusively shown that the pickers working by the day average on the whole much better work. On the other hand, good work can be secured with either the box-payment or day-payment plan if the labor is properly supervised. The character of work done by a picking crew depends on the foreman, and the responsibility for the field handling rests primarily with him. An efficient foreman can secure careful work under either system of payment, though much more easily and surely where the pickers are paid by the day.

Relation of Field Handling to Cooperative and Organized Marketing

The importance of proper field handling is fully recognized by most cooperative and marketing organizations which attend to the preparation of the fruit for market as well as the selling and distribution end of the business. The fruit brought into an association packing house during any one day usually comes from a great many growers in the surrounding territory, and after it has been properly weighed and graded it loses its identity as far as the grower is concerned. This means that each car shipped may contain fruit from a great many growers. Careful investigation of the character of work performed by different picking crews, especially where the picking is done by the growers or under their direction, has shown that there is a great difference in the kind of work being done. One grower may pick his fruit with the greatest possible care, while his neighbor may do exactly the opposite. The fruit from both growers may be shipped in the same car, the carefully handled fruit arriving in sound condition, the fruit carelessly handled developing much decay in transit and at the market. The poor work of one grower in picking in this way nullifies to a considerable extent the good work of the other.

[fol. 535] The different associations have therefore found it to their advantage, and in most cases necessary, to take over and assume full responsibility for the field handling of their growers, through employing trained crews properly supervised to do the picking. This insures uniformity in the handling of the fruit of all growers throughout all the harvesting operations and serves to place all growers on the same and a just basis. Practical experience and careful investigation of the facts in the matter have conclusively shown this to be the most satisfactory way of managing the field end in an organization handling citrus fruits from several growers, especially if the fruit from the different growers is pooled or shipped in the same car. The merchantable condition of the fruit depends primarily upon the kind of handling given it in preparing it for market. Commercial experience has shown that it is almost impossible to secure uniformly good results where the picking and field handling are left to the individual grower. Even

if the grower realizes the necessity for careful handling, he does not always know just what careful handling means or the seriousness of injuries in handling, nor can he employ the trained labor or supervise it to the extent possible where the crews are employed by an association or organization throughout the harvesting season.

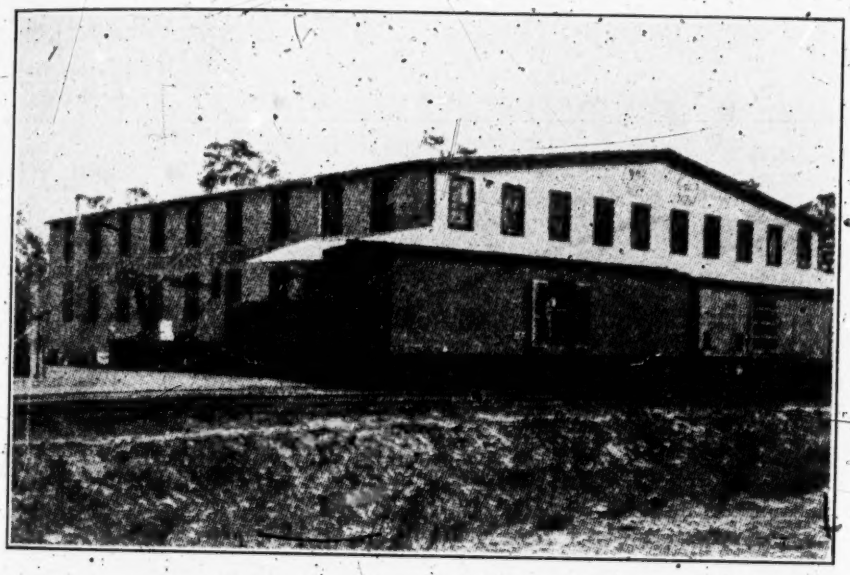


Fig. 4.—A two-story building with excellent facilities for packing and shipping citrus fruits

Packing-house Handling

Wherever possible, it is desirable to locate the packing house near the railroad, in order that the fruit after it is packed can be loaded directly into the car from a loading platform without further hauling or loading and unloading from a wagon (fig. 4). No attempt will be made to give definite plans for a packing house, as the size, equipment, arrangement, etc., must necessarily depend on the quantity and character of fruit to be handled. In general, it may be said that the best packing house is not necessarily the one that has the most machinery in it or that costs the most. The size of a packing house and the character of its equipment will depend largely upon the amount of fruit to be handled and whether the fruit has to be washed or cleaned. In equipping and arranging the machinery the one thing

[fol. 536]

that should be kept in mind more than any other is simplicity. The fruit should be kept on one level as much as possible, from the hopper or washing machine to the packing bins (fig. 5). Gravity runs, drops, and sharp turns or angles should be avoided as far as possible. At no point in the handling operations should the fruit actually be dropped more than 3 or 4 inches; in fact, practically no drop is necessary, if the house is properly arranged, with the exception of the drop from the sizers into the packing

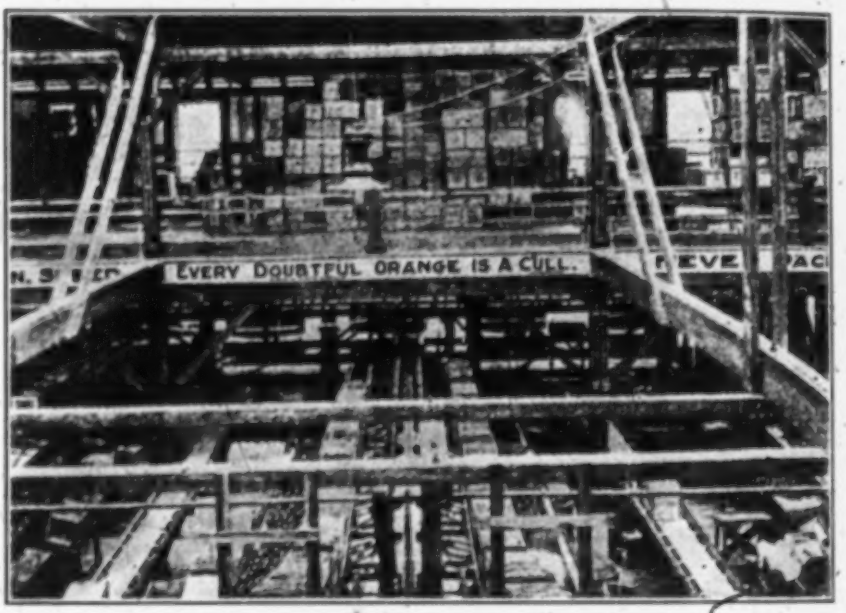


Fig. 5.—Interior of a well-arranged packing house. Note the grading belts in the rear in the well-lighted portion of the house, the carrier, or chute, for empty boxes above the packing bins, the stands for the packing boxes, and the carrier for the packed fruit.

bins, and 3 inches should be the maximum even here. A well-lighted packing house is essential to proper grading and good work generally. The importance of good sanitation and of keeping the house absolutely clean and free from rubbish and decaying fruit can not be overestimated. Decayed fruit in or near the packing house is a prolific source of blue-mold infection and a sure indication of inefficient or indifferent management.

[fol. 537] Sufficient room should be provided inside the house for stacking the fruit hauled in from the orchard

and for packed fruit awaiting loading. Space ordinarily is provided in the second story for box shooks and the making of them into boxes. Gravity runways or chutes can easily be provided for carrying the made-up boxes down to the packing room, where they can be easily reached by the packers.

Use of the Hopper

Where washing is not necessary, the fruit is usually first emptied into a hopper, after which it passes either over dry brushes or directly to the grading belts. A hopper holding not more than two boxes of fruit is desirable. It should be well padded and have only sufficient slant to provide for the easy movement of the fruit. In emptying from the field box to the hopper, the greatest care should be exercised to transfer the fruit without dropping it or throwing it any distance. This operation can be accomplished with little or no injury either by holding the fruit back with the arm or hands in emptying or by using a canvas cloth to hold the fruit back, so as to allow it to roll out easily and gently from the box into the hopper.

Considerable injury is often caused by carelessly emptying or virtually throwing the fruit from the field box into the hopper and by the use of hoppers that are altogether too large. Not only should the utmost care be exercised in placing the fruit in the hopper, but the hopper itself should be kept absolutely free from twigs, gravel, sharp edges, or protruding nails that would injure the fruit placed in it. Formerly very large hoppers were used, frequently holding a wagonload or more of fruit, the grading being done at the lower end of the hopper before the fruit passed to the sizing machine. This type of equipment, however, has been almost entirely replaced by the smaller hopper and canvas or roller conveyer belts for grading.

Washing and Cleaning

In many sections of the Gulf coast region where citrus fruits are grown, the washing or cleaning of the fruit prior to packing is absolutely necessary, in order to remove the sooty-mold fungus which follows the attacks of the white fly and other insects. Washing will continue to be one of the necessary handling operations until the growers take the

necessary steps to control the white fly in citrus groves and to grow clean, bright fruit. If it were possible to do away with washing entirely, a great deal of decay occurring in citrus fruits in transit and while being held on the market could be prevented. There is little or no question that if the losses resulting from the washing and drying operations could be saved, the expense of time and money necessary to grow clean fruit would be more than compensated for[1] [fol. 538] However, if the fruit is in such condition that it has to be washed, it is essential that every precaution be taken to perform this operation in such a way as to inflict as little injury as possible on the fruit as it passes through the washing machine. Washing and drying are the most complicated processes through which the fruit is put in a packing house, and these combined operations involve a great deal of extra handling, which furnishes additional opportunities for mechanical injuries. Extensive investigations have shown that the decay in packed fruit is largely due to injuries received or aggravated during the operations of washing and drying, and the bad effects following washing are due not so much to actual injuries made in passing fruit through the machine as to the inoculation of injured and bruised spots with fungous spores through the agency of dirty and infected water. Injuries made in the grove or in other operations of handling, or injuries made as the fruit passes through the machinery, are aggravated by the addition of moisture, especially when the water is not clean.

The three main causes of decay following the washing and drying operations are (1) dirty and infected water in the soaking tank, (2) poorly constructed or operated washing machinery, and (3) the slow or but partial drying of the fruit under unfavorable climatic conditions. The first can largely be obviated by the proper handling of the fruit in the field and in hauling, so as to bring it to the washer in sound,

---

[1]For information regarding the control of the white fly and other insects which attack citrus fruits, write to the Bureau of Entomology, Department of Agriculture, Washington, D. C. The agricultural experiment stations located in the States where citrus fruits are grown will furnish bulletins and information in reference to the control of insects.

uninjured condition, and by frequently changing the water in the washing tank, or by the elimination of the washing tank entirely where possible and the substitution of a spray before the fruit reaches the washing machine, in addition to the spraying of it as it goes through or over the brushes. Where the fruit is badly covered with sooty mold, a soaking tank is almost a necessity. Where used, the water should be changed frequently, at least two or three times a day. No definite or particular make of washing machine can be recommended, but, in general, the following points and requirements should be kept in mind:

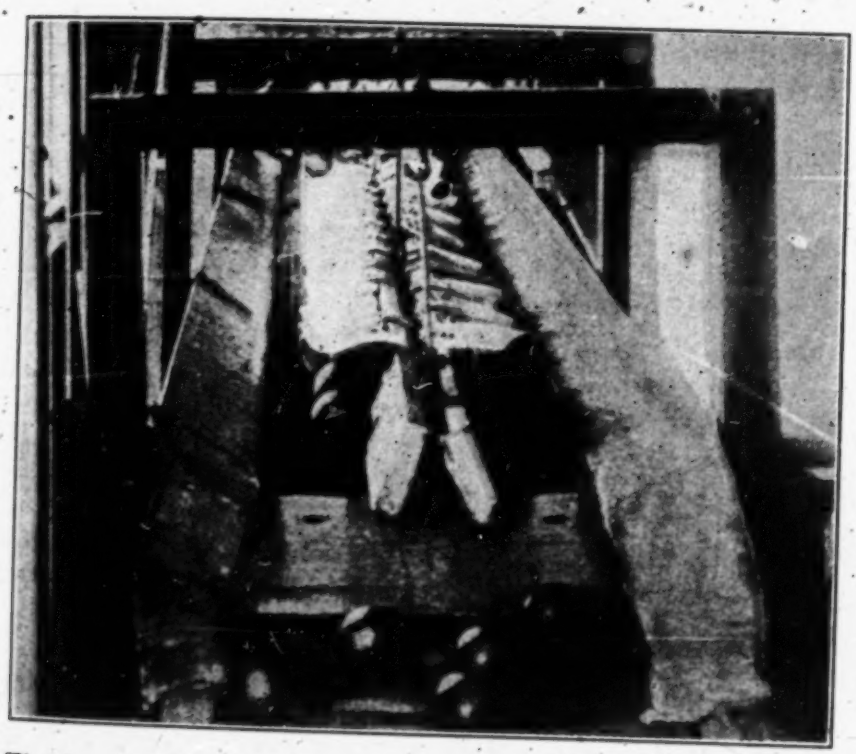


Fig. 6.—A type of washer in common use for cleaning citrus fruits

The fruit should be constantly in plain sight while going through the washing machine; there should be no pressure or weight on top of it or any considerable pressure laterally, the cleaning being done entirely by the weight of the fruit itself in passing over the brushes or other cleaning devices (fig. 6).

There should be little or no opportunity for the fruits to tumble over or rub against one another.

It is essential that the machine be kept thoroughly clean and free from twigs, protruding nails, or anything of that sort that would injure fruit going through it.

After having selected a machine of the type fulfilling as nearly as possible these requirements, the amount of injury incurred in washing will depend largely upon its operation and upkeep. Frequent inspection of the machine is desirable, in order that the worn-out brushes may be re- [fol. 539] placed with new ones. Without such inspection from time to time, some little thing may get out of order that will cause an enormous amount of injury and consequent decay of fruit.

Drying

After the fruit has been washed, it may be run through dry brushes or directly to a drier or to drying racks. Of late, most of the packing houses, at least the larger ones, have substituted artificial driers for the drying racks so common a few years ago. A drying rack, if properly handled and placed, may from some standpoints be satisfactory. If placed outside of the packing house, drying can be done only during favorable weather. To place the drying rack inside the house means the elevation of the fruit a considerable distance and the rolling of this fruit down rather steep gravity runs. It is almost impossible to keep such devices free from splinters and to handle the fruit on them without inflicting more or less injury.

The artificial driers now in use are open to somewhat the same objection, in that they do not do satisfactory work under the most unfavorable climatic conditions or during prolonged periods of rainy weather. Great improvements in driers, however, are constantly being made, and, where [fol. 540] properly handled, more satisfactory work can be obtained with artificial driers than with the ordinary drying racks. These driers are usually made in the form of a long box, through which the fruit is carried on roller conveyers one or more times. The drying is accomplished by forcing a considerable volume of air through this box either from one end or, more commonly, from several points along

the sides or top or through the bottom of the drier, in order to distribute the air more evenly. Under dry, sunshiny conditions, the ordinary air usually serves the purpose, but during cloudy and rainy weather it is necessary to heat the air somewhat, in order to accomplish thorough drying during the time the fruit is passing through the drier. Under very unfavorable climatic conditions, such as occur frequently during the harvesting and picking season, it is exceedingly difficult to do thorough drying, even with warm or heated air.

It is of the greatest importance that the fruit be thoroughly and quickly dried. The blue-mold spores require moisture for germination, and if the fruit is left for any length of time in a moist condition, or if packed while still wet, ideal conditions for the germination of these spores are provided, and if any of the oranges are injured decay is certain to result.

Grading

The fruit is usually run on to grading belts directly from the drier. These grading belts may be either of canvas or in the form of roller conveyers which keep turning the fruit as it passes before the graders. In order to do grading properly, it is necessary to have good light. This point can hardly be overemphasized, as one of the most common mistakes in building a packing house is to provide insufficient light for grading. Generally speaking, there are no uniform rules for grading oranges and grapefruit in Florida, and, as a rule, only two classes are made—brights and russets. In the bright class, or first grade, is placed all bright, well-colored fruit, while the second grade, or russet, is usually composed of fruit more or less affected by the work of the rust mite, by melanose, or by other skin blemishes. The finest of the brights may be packed as "Fancy" or some of the brightest russets may be labeled "Golden." Sometimes, however, similar grades of fruit from different packing houses may be sold under entirely different grade names. The tendency now is to establish more uniform regulations regarding grading, to market certain grades under established brands, and never to ship under such brands any but fruit coming up to the specified grade.

The grading of the fruit, however, is entirely without reference to the size of the fruit. Whatever grades are made or established, it is of the greatest importance that the grading rules be strictly adhered to and that the first grade contain no fruit except such as is clean and free from [fol. 541] blemish and which comes up to the first-grade requirements in every way. If there exists any doubt regarding the grade in which the fruit is to be placed, it is preferable to place it in a lower rather than in a higher grade. The uniformity of grading and the dependability of grades do much to establish the reputation of particular brands on the market. Good grading goes hand in hand with good careful work in the other operations of harvesting and handling.

Sizing

In equipping a packing house, separate sizers are usually provided for each grade and one bin for each size of a grade. After the fruit is properly graded it continues on either canvas or roller conveyer belts to the mechanical sizers and thence into the packing bins. The sizers should be selected primarily with reference to the accuracy of sizing and the ease with which the fruit is handled, and great care should be exercised in constructing and arranging the bins to guard both against long drops from the sizer to the bin and the piling up of fruit in the portion of the bin next to the sizer to such an extent as to interfere with the proper sizing of the fruit. Accuracy in sizing is of great importance in determining the appearance of the pack and the price paid for the fruit at the market end. Good fruit, uniformly well graded and sized and in sound condition, soon gains a reputation for soundness, quality, and dependability that commands for it the highest market price throughout the season.

Packing

Good packing involves both science and art. Next to soundness and keeping quality, the appearance and attractiveness of the pack are the greatest factors in determining the market price of fruit, and it is therefore of the greatest importance that this part of the handling operations be carefully and efficiently supervised. During the last few years attempts have been made to put up what are called

bulge or high packs, as against the former practice of putting up a pack that was practically flat and even with the ends of the box. While a high pack is desirable, at least from a marketing standpoint, there are certain features and methods of procuring such a pack that should be kept clearly in mind. Oftentimes the fruit is packed loosely in the box, the last layer protruding considerably above both ends and sides of the packing box, the bulge being obtained by squeezing the fruit down at the ends when nailing on the cover. However, even though the fruit may have the desired appearance at the time it is loaded into the car, it settles in transit and when it arrives on the market the box is slack and has a very poor appearance. The squeezing of the fruit down into the ends of the box by means of the cover also results in a great deal of injury and decay in transit.

[fol. 542] The best pack for all purposes is a firm, moderately high one, all of the fruit being packed in tightly from bottom to top. After some experience the packer will have no difficulty in securing the desired bulge with this firm pack. If the fruit throughout is firmly and tightly packed and it remains in sound condition, the pack will not become slack in transit, as is the case where the fruit is rather loosely packed in the bottom of the box.

Considerable injury is done by dragging the oranges around in the bins and tossing the off sizes into neighboring bins. Every packer should wear a glove, at least on the hand which picks up the fruit, so as to avoid finger-nail scratching. The packing bin should be thoroughly padded and kept free from dry twigs and other trash, and the drop from the sizer to the bin should be the shortest possible.

In the packing of citrus fruits, each fruit is wrapped in thin wrapping paper, different sizes of paper being used in accordance with the size of the fruit being packed. In wrapping citrus fruits preparatory to packing, the stem should always be placed in the twist of the paper and the fruit should be tightly wrapped in such a manner that the paper will not fall off the from the fruit when taken out of the box, without being removed by hand. Poor wrapping and inattention to placing the stem of the fruit in the twist are but another sign of careless work and inefficient management. The name of the grower, association, or marketing organization, with its brand or trade mark, is very fre-

quently printed on the wrapping-paper. Some houses pack all but the bottom and top layers in plain papers, using the paper with the brand printed on it only for the top and bottom layers. It would seem, however, to be more consistent and preferable to use the printed paper throughout the package, if at all. The usual sizes of round oranges run from 96 to 288, the more common sizes being 126, 150, 176, 200, and 216 to the box. Figure 7 gives a diagrammatic representation of the method of placing the fruits of various sizes in the packing box. The arrangement as shown in the box end to the left is that for the first or the bottom layer; the one on the right is the second layer, which is placed on top of the first. The third layer is the same as the first, and the fourth the same as the second, and so on.

Figure 8 gives a diagrammatic illustration of the method of packing grapefruit of the different sizes, with the arrangement of fruits in each layer, the number of layers in each end, and the approximate diameters as ordinarily used. Certain sizes are oftentimes packed differently from the arrangement shown in the diagram, the packs here illustrated being the ones more commonly used and preferred at the present time. The sizes and number of grapefruit in a box may vary from 18 to 96, the most common sizes usually running 46, 54, 64, and 80 to the box. The diameters given [fol. 543] both for oranges and grapefruit are average diameters only, these being varied somewhat in accordance with the shape of the fruit and the tightness of pack desired. The boxes commonly used for either oranges or grapefruit contain a space of almost exactly 2 cubic feet, the outside measurements approximating 12½ by 12½ by 27 inches.

Sizing and Packing Mandarin Oranges

Tangerines, mandarins, and King and Satsuma oranges are usually packed in half boxes, or "straps." The sizes for these fruits usually run from 48 to 216, the most common sizes being intermediate between these two. Figure 9 illustrates the arrangement of various sizes of these fruits in packing. There is some variation in different sections, of course, in the method of packing these sizes, the arrange- [fol. 544] ments illustrated being the ones in most common use. In shipping, two of these boxes are usually strapped

together and loaded the same as one box of round oranges or grapefruit.

In the Mobile section of Alabama and other districts of the Gulf coast where Satsuma oranges are grown on a con-

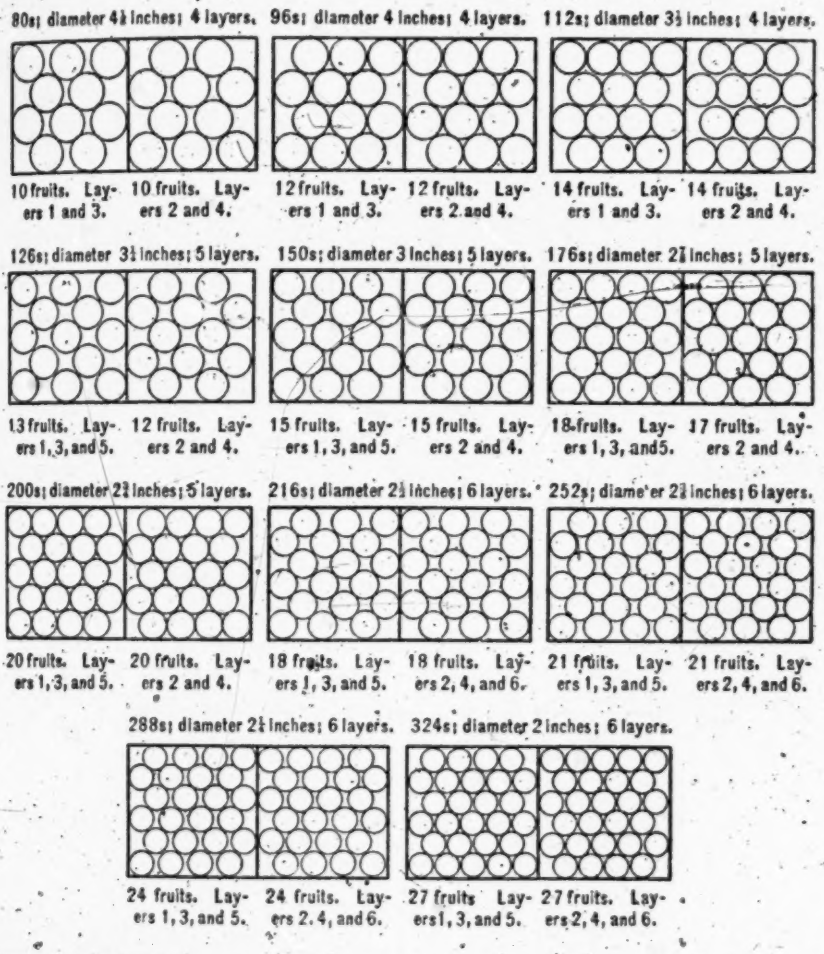


Fig. 7.—Diagrams illustrating the arrangement and methods of packing sweet or round oranges of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

siderable scale, more attention is being given to the development of distinctive Satsuma packs. The methods of

packing Satsuma oranges in the sections outside of Florida are very similar to those illustrated for mandarin oranges. Practically the same box is used, one measuring approximately 12 by 6 by 24 inches inside measurement and having a capacity of 1 cubic foot. The arrangement of the packs is essentially the same, the principal difference being that the sizes generally run about one-quarter inch larger than those given in figure 9. This necessitates somewhat tighter

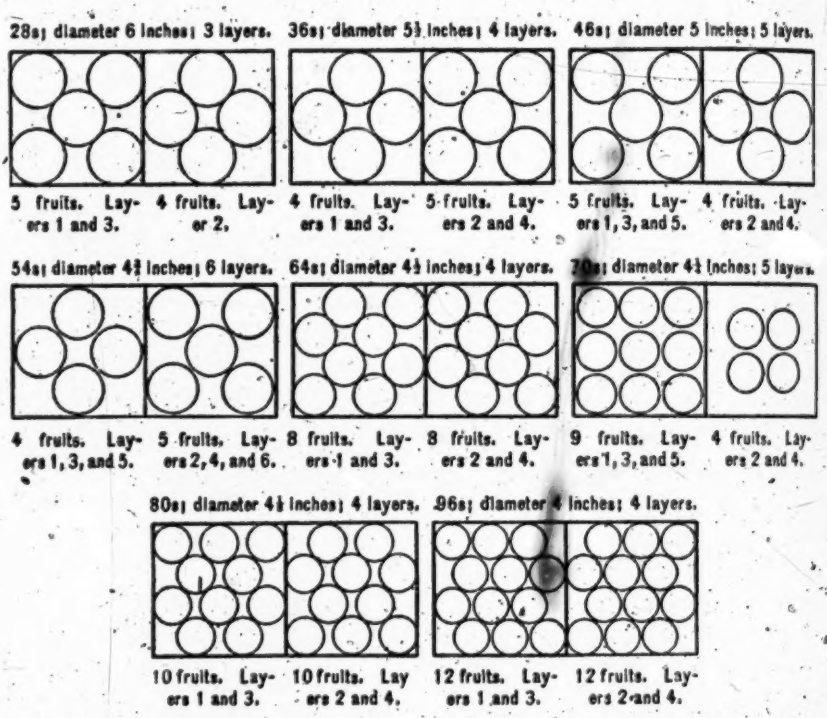


Fig. 8.—Diagrams illustrating the arrangement and methods of packing grapefruit of different sizes in layers in standard boxes. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

packing and tends to give the pack a considerable bulge. In addition to the packs illustrated in figure 9, packs with 240 and 288 fruits to the box are used to some extent. The fruits in the 240 pack have a diameter of 2¼ inches and are packed 4 and 4 in six rows of five layers. In the 288 pack

the oranges having a diameter of approximately 2⅛ inches are packed 4 and 4 in six rows of six layers.

[fol. 545] Nailing

Many modern packing houses, especially the larger ones, have installed roller conveyers or some other conveyer device for carrying the packed box from the packer to the

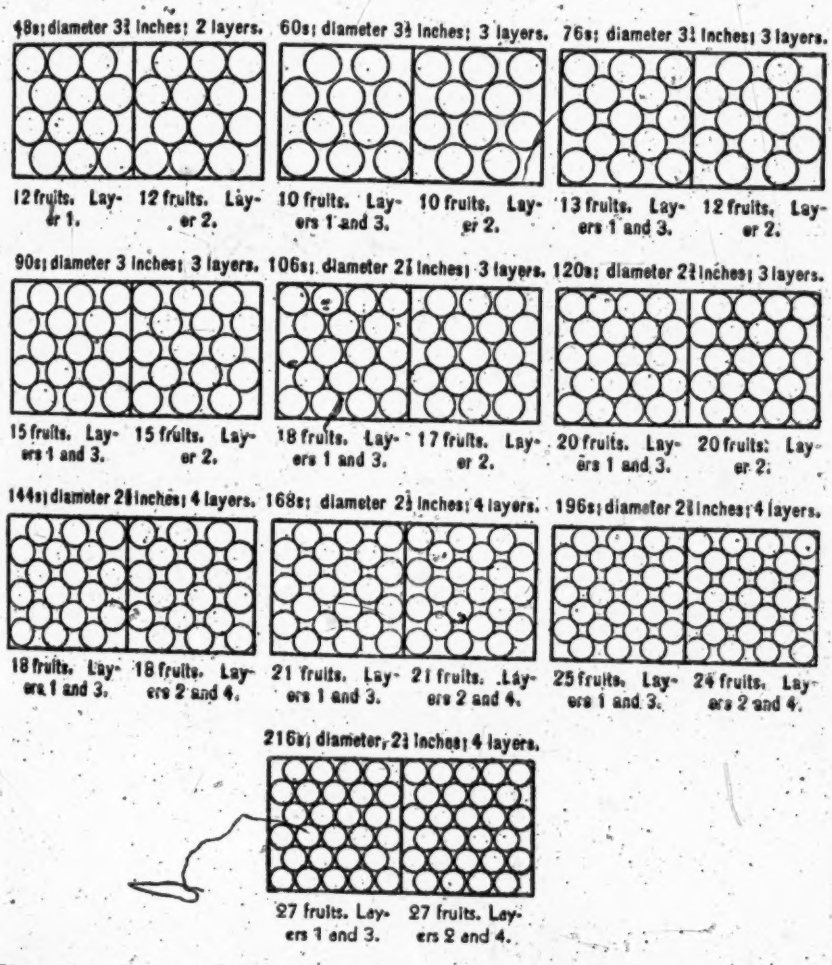


Fig. 9.—Diagrams illustrating the arrangement and methods of packing mandarins, tangarines, and King and Satsuma oranges in layers in standard half-size boxes or straps. The number of fruits and the approximate diameter of each fruit in the box and the number of layers in each end are given above each diagram. The number of fruits in each layer is shown below the diagram.

nailing bench. Where these are provided, all that the packer has to do is to remove the box from the inclined bench holding the packed box to the conveyer alongside. The cover may be nailed on, either with or without the use of a press (fig. 10). In either case great care should be taken in putting on the cover to prevent injury to the top layer as the fruit is necessarily pressed down at the ends and the sides. If the center of the box and the inside edges of the ends, as well as the sides of the box, are beveled, the

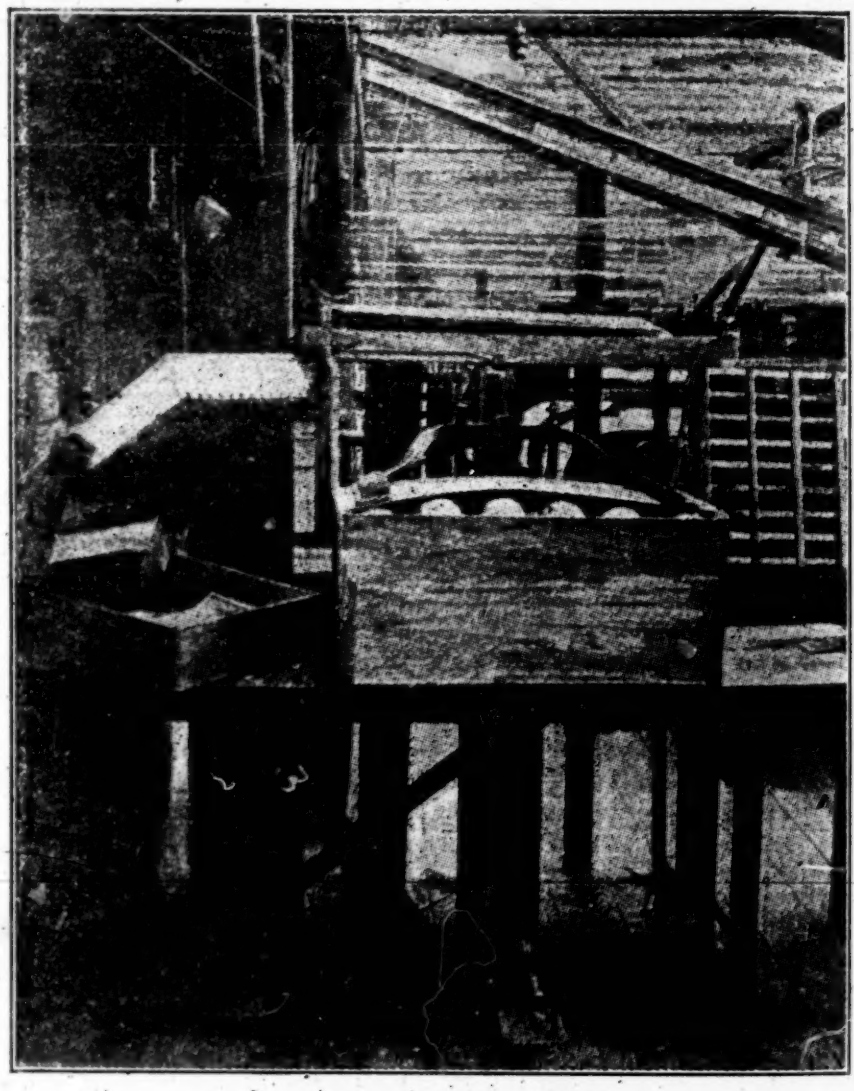


Fig. 10.—A box press used for putting on the cover of a packed box of citrus fruits

liability to injury in putting on the cover is very much decreased.

[fol. 546] Formerly all the boxes were bound with there wooden straps, one around each end and one around the middle. While these still are being used to a considerable extent, metal straps have come into quite general use. These straps are usually nailed on three sides when the box is made up and looped over the top and firmly nailed in place after the cover has been put on. In some of the packing houses the end straps are omitted entirely.

Loading

It is of great importance that the boxes be so loaded in the car that there will be no shifting or breakage in transit. [fol. 547] The fruit is often loaded either on end or on the side, without cleating or bracing. A safer and better method, however, is to load all boxes on end two tiers high throughout the car. The most common loads are 300, 330, and 360 boxes. The 300 load is secured by loading five rows across, 30 boxes long and 2 boxes high. The 360 load is secured by loading six rows across, 30 boxes long and 2 boxes high. In loading 360 boxes in a car the bottom tier is the same as with 360, while in the upper tier some of the boxes are usually laid on their sides through the middle of the car. Each row should have two substantial car strips nailed across the ends of the boxes, one strip being shoved tightly up against the car wall on one side, while the other strip on the same row of boxes should be placed tight against the opposite car wall. If this method is used, it will prevent the shifting of the load in any direction.

Curing

In some citrus sections of the Gulf coast region the curing or holding of oranges and grapefruit for a few days prior to packing and shipping is still practiced. The principal arguments in favor of curing have been that the holding of the fruit for a considerable time in the packing house will permit the throwing out of fruit predisposed to or showing decay and the putting up of a tighter, firmer, and more attractive pack, owing to the greater pliability of the fruit. The arguments do not seem to be well founded and the prac-

tice itself seems to be not justified. Both investigational and commercial results have clearly demonstrated that because of the slow development and growth of the blue-mold fungus the decay ordinarily does not develop sufficiently during the curing period to be distinguished and thrown out by the graders. Moreover, delayed fruit, mechanically injured almost without exception, shows considerably more decay both on and after arrival at the market than similar fruit packed and shipped immediately. As regards the claim that wilting or curing is necessary in order to put up a tight, firm pack without injury, practical experience has demonstrated that a pack fully as firm and as attractive in appearance can be put up the same day the fruit is picked from the tree. The holding of the fruit in the packing house during a curing period permits added opportunity for infection and affords ideal conditions for the development of blue-mold decay in transit and at the market. In view of the increased decay that is likely to result from curing and the entire practicability of putting up without injury a tight, firm pack without wilting or curing, all citrus fruits except lemons and perhaps limes should be shipped as soon as possible after removal from the tree.

Methods of Shipment

Citrus fruits from the Gulf States may be transported by several routes and under as many methods of shipment. [fol. 548] The great bulk of the fruit from Florida and the other older citrus sections in the Gulf States is shipped by rail in full carload lots under either ventilation or refrigeration. Small consignments are sometimes forwarded either by express or by freight to near-by and distant markets or to assembling points for reshipment either by rail or by water. Considerable fruit is shipped by water from Jacksonville, Savannah, and other Gulf coast ports and from points on the Mississippi River in Louisiana.

Refrigeration

Up to within a few years, practically none of the citrus-fruit shipments from Florida were carried under refrigeration. The prevailing opinion has been that citrus fruits do not need refrigeration, especially as most of the crop is moved during the winter months when the outdoor tempera-

tures in all but the Gulf States are low; so low, in fact, that the problem has been to protect the fruit against freezing. In order to avoid, as far as possible, damage by freezing, citrus fruits are now almost universally transported in refrigerator cars whether under ventilation or refrigeration.

During the warmer periods of the shipping season and during periods when decay is unusually heavy, a considerable proportion of the shipments are now iced. The shippers generally claim that shipments under refrigeration, especially during such periods as are above mentioned, arrive in sufficiently better condition to more than offset the added cost. There is little or no question regarding the value of refrigeration for citrus fruits under certain conditions; nevertheless, there are certain points that should be kept clearly in mind.

The investigations of the Department of Agriculture have conclusively demonstrated that oranges and other citrus fruits can be transported to market under ventilation with the minimum amount of decay, even during periods of warm, humid weather, provided sufficient care is exercised to preserve the skin of the fruit in a sound, unbroken condition. The use of refrigeration in transit can not be depended upon to offset the effects of rough or careless handling. The low temperatures secured by icing may arrest or retard the development of decay fungi only to have decay develop rapidly after unloading or exposure to warmer temperatures. Thus, while the fruit may arrive in practically sound condition it will gain a reputation for poor market-holding quality if it has been injured by careless handling. It is fully as important in the long run that fruit possess good keeping quality on the market as that it arrive in sound condition.

It should also be kept clearly in mind that the cooling of the fruit in a refrigerator car even where the ice bunkers are full is exceedingly slow. Extensive investigations of temperatures of citrus fruits in transit under various [fol. 549] methods of shipment have shown that it takes five to seven days for the ice in a refrigerator car to bring the temperature of all of the fruit in the car down to a point where ice can maintain it. During the first part of the journey a great deal of the fruit is not cooled to any considerable extent, permitting the germination and growth

under very favorable moisture conditions of blue-mold and other decay organisms. If these fungi start growth and development during the first part of the journey, while the temperatures in most portions of the car are relatively high, the lowest temperatures that can be maintained in an iced car will not entirely retard further growth and development.

Precooling

Precooling is the term employed to designate the quick and prompt cooling of fruits, vegetables, and other produce prior to shipment. The primary object of precooling is obviously the delivery of perishable produce at the markets in a fresher, sounder, and more wholesome condition than is possible under either ventilation or ordinary refrigeration. If precooling properly done fails in this respect or does not bring increased returns commensurate with the extra expense involved, it is not justifiable from a commercial or any other standpoint.

As already pointed out, under ordinary refrigeration the rate of cooling is exceedingly slow, the ice being required not only to take the heat out of the fruit but also to take up the heat leakage through the car walls. On the other hand, if the fruit is thoroughly cooled before shipment, the ice has only to maintain low temperatures against the leakage of warmer air through the car. One of the main objects of the prompt cooling of citrus fruits in the Gulf States is to prevent the germination of blue-mold spores and to retard or arrest the development of stem-end decay. While blue mold will continue to grow and develop at temperatures even as low as freezing, spore germination takes place but slowly at 40° F. The stem-end decay fungus grows and develops but slowly at temperatures below 40°, and it is not very active at temperatures between 40° and 50° F. The beneficial effects, therefore, of precooling citrus fruits as regards decay in transit and on the market result from the provision and maintenance of low temperatures unfavorable to any but slow germination of fungous spores and to the growth of fungi such as cause blue mold and stem-end decay.

Precooling, like refrigeration, should not be depended upon to overcome the injurious effects of rough and careless

handling. However, during the citrus shipping season there oftentimes occur periods of extremely rainy, warm, and unfavorable weather when fruits are not only unusually tender but when practically every injury results in decay. The problem of commercially handling citrus fruits [fol. 550] so as to preserve the skin of the fruit in a sound, unbroken, condition is, to say the least, under such conditions most difficult. Where the trees are thorny and full of dead wood, some injury is bound to occur, either through high winds before picking, or in placing the ladders, or in removing the fruit from the tree. It is during warm, moist periods that stem-end decay is frequently most severe. Refrigeration in transit is employed, more especially when fruit has been handled under unfavorable weather conditions, to retard the growth and development of the fungous organisms causing decay. While the decay on arrival has been somewhat lessened through the use of refrigeration, the rapid development of decay after the arrival of the fruit on the market makes refrigeration sometimes of doubtful value.

It is during such unfavorable weather conditions, when high decay occurs in a great many shipments, and during the warmer weather toward the end of the shipping season that precooling should be of greatest value.

Precooling citrus fruits in the Gulf States had not been attempted either experimentally or commercially prior to the season of 1913-14, although it has had considerable commercial application in the citrus and deciduous fruit districts of California for a number of years. During the last two seasons the Department of Agriculture has conducted extensive and careful investigations of the relationship of precooling to the decay of Florida oranges in transit and on the market. The results of these investigations and the results obtained in commercial plants erected prior to the opening of the 1914-15 season indicate that precooling is a valuable aid to careful and proper handling in insuring sound condition on arrival and for a period of about 10 days after arrival at the market. Proper handling with precooling may be the means of insuring the delivery of sound oranges throughout the whole shipping season. One of the most difficult problems heretofore has been that of

uniformly placing the fruit on the market in good, sound condition and the establishing of a reputation for dependable keeping quality throughout the season. Both the investigational and commercial results indicate that precooling has peculiar application in the transportation of citrus fruits, especially oranges, from the Gulf States, particularly in view of the fact that during the greater part of the season precooled shipments can be forwarded with initial icing only. During about three months in the winter the maintenance of low temperatures in transit is entirely practicable by thorough precooling, even without initial icing en route. Even where initial icing is used in the transportation of precooled shipments the combined cost of precooling and initial icing is considerably below the average cost of full refrigeration.

[fol. 551] In general, there are two ways of doing precooling, the car or the warehouse method. In car precooling the fruit is first loaded into a refrigerator car ready for shipment, after which cold air is circulated through the load, forced in either through the ice bunkers or through the car door. In the warehouse method the fruit is first cooled in the warehouse cooling rooms before being loaded into the car for shipment. Where the precooling is done after the cars are loaded, cooling can not be commenced until the car is fully loaded and transported to the precooling plant. This necessarily involves some delay before cooling, such delay, if considerable, corresponding in a way to the delayed cooling of fruit under ordinary refrigeration. In the warehouse type of plant the fruit can be placed in the cooling rooms as soon as it is packed, and the cooling accomplished with less delay. As a rule, the cooling is more uniform in a warehouse plant and less refrigeration is required than in car precooling, as there is less leakage through the walls of the storage house than in the case of an ordinary refrigerator car. The refrigeration in a warehouse can be secured either by the use of an ammonia plant or from a mixture of ice and salt. For small associations, especially where an ice can be obtained at a reasonable price, ice and salt plants are both practical and probably more economical than the more expensive ammonia plants. In this system, refrigeration is secured by drawing the air through the bottom of an insulated tank filled with a mix-

ture of ice and salt. The temperature of the air after it has passed through this mixture will depend upon the percentage of salt mixed with the ice. Air is forced through a false floor in the cooling room up through and between the boxes of fruit and is again taken back to the ice tanks through ducts in the ceiling of the cooling room. This type of plant is, as far as equipment is concerned, very inexpensive and is especially applicable to sections where the shipping season is relatively short and where the output is not large enough to justify a larger and more expensive ammonia plant. No engineer is required for its operation, as any man with ordinary common sense can operate it efficiently.

Whatever method of precooling is used, it is essential that the fruit be cooled as promptly as possible after removal from the tree and that the cooling be thorough. Any considerable delay in cooling or failure to cool thoroughly may nullify any benefit that would result if the precooling had been done promptly and thoroughly.

Cold Storage

Neither oranges nor grapefruit are held in cold storage to any extent in the producing districts prior to shipment to the markets. Limited quantities of both oranges and grapefruit are, however, frequently placed in cold storage at the market end. The success with which sound fruit can be held in storage depends primarily on two factors, the [fol. 552] length of the time in storage and the temperature at which it is held. Oranges, grapefruit, and lemons should be stored at temperatures considerably above 32° F.; oranges at 38° to 40°, lemons at about 42°, and grapefruit at 45° to 50°. Even at these temperatures the period of successful storage is comparatively short, not usually exceeding two months and frequently not more than a month or six weeks. Oranges take on a sort of brown stain in storage, in addition to being just as susceptible to serious spotting due to attacks of Colletotrichum as are grapefruit and lemons. This spotting is much more severe at low temperatures, particularly 32° F. It almost invariably develops on oranges or grapefruit when held for any length of time at 32°, or even on fruit held at more favorable temper-

atures too long. Frequent inspection should be made of fruit in storage, in order that any showing signs of spotting may be immediately removed and disposed of.

[fol. 553] PLAINTIFFS' EXHIBIT No. 33

Citrus Fruits

An Account of the Citrus Fruit Industry with Special Reference to California Requirements and Practices and Similar Conditions

By J. Eliot Coit, M.S.A., Ph.D., Professor of Citriculture in the University of California and Citriculturist to the University of California Agricultural Experiment Station, Formerly Superintendent in Charge Citrus Experiment Station, Riverside, California

New York

The Macmillan Company, 1915

All Rights Reserved

P. 306: the ceiling at all times. If the air is allowed to become dry, the lemons will quickly shrivel. The temperature should be kept at 90° F. or ten degrees lower than for oranges. So far it has been impossible to fully color green lemons in five days and retain the buttons, as the same quality of the gas mixture which changes the color causes the buttons to drop off. Inasmuch as sweated lemons are sold and consumed quickly, the loss of the buttons is not as serious a matter as would otherwise be the case.

Storage of Winter Lemons

In the late winter and spring when it becomes advisable to hold the fruit for summer markets, the problem of the lemon packer is very different from that of early fall. Instead of sweating the fruit and thus accelerating the life processes as much as possible, he now wishes to retard to the greatest possible degree these same life processes. The

fruit is therefore picked with very great care in order to prevent abrasions. On arriving at the packing-house the lemons are carefully washed in a brush washer. For disinfection against brown rot, one pound of bluestone is added to each 1,000 gallons of wash water in the morning and one-[fol. 554] half pound added to the same water at noon, the water being changed each morning. To prevent the bluestone from corroding metal tanks it is well to apply a thick coat of asphaltum paint to the inside of the tank.

The lemons are now separated into three grades according to color alone, known as green, silver, and tree-ripe; the silver being those fruits which are just beginning to lose the deep green color. Each of these grades is placed

P. 387: alkali the bluestone may be neutralized, and in such cases a chemist should be employed to study the water and advise as to the proper procedure to keep the solution of bluestone as near as possible at a strength of 1/50 of one per cent.

In order to reduce to a minimum the loss of lemons on the trees it is advisable to keep the branches pruned up somewhat from the ground, and summer cultivation should extend well under the trees. It has been found well worth while also to spray the ground under the trees each fall before the rains begin with Bordeaux mixture, as this largely prevents the fungus from fruiting at the surface of the ground.

Blue Mold (Penicillium italicum) and Green Mold (P. digitatum)

Most of the decay of citrus fruit is due to blue and green molds. Being only very slightly parasitic on uninjured fruit, the decay is practically confined, under ordinary conditions, to fruit which has been injured in handling. The spores of these fungi are very common in the air everywhere and are almost sure to get into any slight abrasion of the skin of fruit. They produce a soft rot while the fungi fruit abundantly over the surface, the spores appearing as a blue or a greenish powder according to which species is present. Frequently the two kinds occur together, although the green is the most universal. For all practical

purposes these two species of penicillium may be treated as one. About the only difference is the color of the spores [fol. 555] and the fact that in pure culture the blue mold shows a wider band of white exposed mycelium between the fruiting area and the sound skin. The universal preventive for these decays is careful handling of the fruit in field and packing-house, which, if conscientiously enforced, will reduce the losses to a minimum.

P. 394: Control measures have not yet been fully worked out. On account of the presence of this fungus, the state of Florida is now quarantined against the introduction of nursery stock or bud-wood from Alabama.

Melanose and Stem End Rot (Phomopsis citri)

These diseases, which are both caused by the same fungus, have been prevalent in Florida for many years. The fungus occurs in Australia, Jamaica, Porto Rico, and Algeria, but so far has not been found to exist in California.

The disease lives normally and produces spores on dead twigs in citrus trees. The spores are washed by the rains over the surface of the fruit, causing, particularly on pomelos, peculiar brownish streaks known as tear-staining or melanose. These marks are nearly the same on leaves, stems, and fruit, and consist of raised areas of brown gum-filled cells forming dots, lines, rings, or irregular spots which greatly injure the general appearance of the fruit while not injuring the eating quality.

Stem-end rot causes the fruit to drop, beginning with immature fruit in August and continuing till after the fruit has been sent to market. It even causes decay after the fruit has reached market. The softening begins at the stem end and is especially common on fruits which have scale insects about the stem end. It is more severe during a warm fall and winter, and infection seems to be more common in damp shady situations. Sound picked fruit can be infected by contact with diseased fruit. The fungus inhabits the soil under infected trees and the spores develop in spring and summer on dead twigs, bark, and on mummified fruits.

[fol. 556] P. 395: The application of fungicides to the trees or disinfectants to the wash-water does not control the disease. The most successful method of control is to keep the trees carefully pruned and free from all dead twigs, stubs, and mummified fruits. The prunings should not be plowed into the soil, but should be removed from the orchard and burned before the fungus has time to grow and produce spores upon this material. All diseased fruit which falls to the ground should be collected and destroyed. Careful culling at the packing-house and refrigeration in transit are aids to control. Also it is advisable to keep the trees as free as possible from scale insects.

Nail-head Rust (Cladosporium herbarum var. citricolum)

In Florida the nail-head rust is quite common, while it has not as yet been found in California. It is often called scaly-bark in Florida, but it is very distinct from the California scaly-bark, the cause of which has not yet been discovered. The disease appears on the twigs and small branches as slightly raised rusty spots, as implied by the name. The fungus also produces spots on the fruits which are hard, circular, sunken, and more or less corky. Affected fruits color and drop prematurely. The spots due to this fungus are found only on sweet oranges. Various control measures have been suggested, such as top-working the trees to pomelos; heading back and spraying with Bordeaux, followed by an insecticide; and carefully pruning out all dead wood.

Scab or Verrucosis (Cladosporium citri).

Citrus scab is another disease which occurs in Florida and other parts of the world but has not so far been found in California. The following description of scab is from the Florida Experiment Station Bulletin No. 108, page 41.

"This disease, which is especially common on sour oranges and lemons, makes its appearance on the fruit as irregular

[fol. 557] PLAINTIFFS' EXHIBIT NO. 34

Proceedings of the Forty-eighth California State Fruit Growers' Convention, Held under the Auspices of the State Commission of Horticulture in Connection with the National Orange Show at San Bernardino, February 18-19, 1916

Sacramento

A. J. Cook, State Commissioner of Horticulture, 1916

has been built. On it hangs thousands of fruit limbs, fruit spurs have set, thousands of buds are ready to produce more fruit-limbs and spurs, more fruit limbs are continually coming into bearing, and unless the tree is properly and regularly fed one cannot expect prolific and continuous fruiting. A lemon tree is very much like a potato in the comparison of the fruit buds with the eyes of the potato. Every bud on the lemon tree is capable of growing fruit limbs and fruit spurs, even down on its trunk to the top of the ground. Keep the food factory in good running order, furnishing the proper diet for the tree. With the proper handling of the soil and the proper training and pruning of the lemon tree, one can develop a tree which will always and indefinitely be a prolific bearer and a profit to its owner.

The Causes of Unnecessary Decay in Lemons

By R. L. Willits, of Corona, California

The work wherein the causes of unnecessary decay in the lemon may occur can be divided into three heads: the grow-[fol. 558] ing, picking and packing. No one can hope to establish a reputation in the markets of this country for firm, good-keeping lemons if there be lack of care in any of the three branches of this work. It has been fully demonstrated to the satisfaction of the shippers of the packs that bring full prices that the trade is willing to pay a good price for careful, intelligent and consistent work, and it has also been demonstrated to the dissatisfaction perhaps of the careless ones that poor work will be discounted, so that it is more expensive in the end than good, careful work.

When all the operations employed in the growing, picking and packing of lemons are organized, and checking methods put into practice so that the responsibility for every part of the work is definitely fixed, the results show that careful work is usually done cheaper than where less careful work is permitted. The fact that careful work is usually cheaper is accounted for by reason of better organization, each employee feeling a certain responsibility for the work he is performing.

The cultural problems that confront the grower who is trying to produce good-keeping lemons are more numerous and harder to solve, perhaps, than those that are met in the other two departments. No one has demonstrated that all lemons can be grown up to size while they are still green, but intelligent effort to come as near as possible to this optimum is well paid for. Cultural methods that will keep the foliage dark green and the trees growing and free from gum disease, scale and other parasites will produce the largest proportion of green lemons that are up to size, and any grower who fails to do whatever is necessary to maintain this condition is increasing the per cent of decay by neglecting his part of the work, as well as the foreman who permits rough handling.

Brown rot was at one time one of the most alarming causes of decay, but with the help of the State University and some of the most progressive growers well defined methods for the prevention of this loss have been worked [fol. 559] out; for instance, the covering of the ground under the tree and out beyond the drip of the branches with some kind of a mulch, or the spraying of the lower branches and the ground with Bordeaux. The latter method is considered the most effectual, and if the trunk of the tree is wet with the spray at the same time, this will help protect against possible infection of the bark by brown rot which causes gum disease. The Bordeaux dries on the fruit and leaves a coating, which protects against infection. The comparatively small amount of Bordeaux that is sprayed on the ground would have little effect in killing all the brown rot that is present in the soil of badly infested orchards, as it has been found scattered through the soil to a depth of

four feet; but when the brown rot attempts to grow to the surface of the ground, a very large part of it is killed by coming in contact with the Bordeaux.

A good cover crop also acts as a check to the spread of the brown rot spores, in that it forms a covering over the ground, and the spores are not so apt to rise up through a thick growing crop and get on the trees. However, a heavy cover crop creates an ideal condition in wet weather for the propagation of another form of decay, commonly known as "cottony rot" or "white mould." This fungus is carried over from one wet season to another in the soil by the sclerotia, or small black bodies that develop in the cottony growth. During wet periods the sclerotia send a growth to the surface of the ground which produce cup-shaped discs in which the spores are produced in microscopic sacs. At the end of the sacs the growth upon drying breaks apart, and the spores are ejected into the air. The sacs are so sensitive that even blowing the breath over them will cause the outer end to break and a cloud of spores to rise into the air.

I have seen trees where a large part of the young lemons and bloom was destroyed by cottony rot. It does not often attack the larger fruit, but when this form of decay gets started in a box of lemons, it soon takes all the fruit in the box, if not discovered in time. There are some kinds of [fol. 560] cover crop in which it seems to thrive better than others. It can be found more abundant, perhaps, in vetch than in any other cover crop in common use, while Melilotus indica, being an upright growing plant, offers less opportunity for the growth of this fungus.

Mr. C. O. Smith of the State Pathological Laboratory at Whittier has done a great deal of work investigating this form of decay, and has prepared a bulletin on the subject, which will, no doubt, be available soon, and which I am sure will be of interest to all lemon growers.

Brown centers, so called, have caused a great deal of loss, especially during the last two seasons, and so far we have been unable to place this loss in the avoidable decay column, but Dr. Webber and his assistants are at work on this problem, and we expect to know more about the cause and control of this decay soon.

A great deal has been said about the different classes of labor employed in picking, and no doubt the good or bad

standing the different classes of pickers have is very largely due to the kind of supervision exercised. The right picking foreman will get good results from almost any of the different classes of help that are available. If a regular inspection of each picker's work is maintained, any poor work is soon discovered, and if the inspections are properly followed up, decay that results from long stems, clipper cuts, and scratches from thorns and dead brush can be greatly reduced, but the responsibility for the work must be definitely fixed in order to get best results.

The damage caused by rough handling in the field is not easily detected by inspecting the fruit in the packing house, unless a very careful and minute examination is made of each lemon. Rough handling should be guarded against by the foreman on the ground, and he, in turn, should be regularly checked up. It is very important that great care should be exercised in the handling of lemons. They should never be dropped any distance at all, not even an inch. [fol. 561] The importance of this may be demonstrated by taking a lemon and dropping it about two inches onto a dry board, and if it is dropped so that it falls on the point, a moist spot will appear on the board, showing the lemon has been damaged.

The picking bag should not be too large. A bag that will hold about twenty-five pounds of fruit is used by some of the most careful concerns, and the opening in the bag should be so arranged that the picker's hand will have to put the lemon in the bag, instead of dropping it into the opening. A wide, open-topped bag will catch more small bits of dead branches and the short pieces of stem that come from making the second cut.

The clippers should be carefully gone over to make sure they are sharp enough to make a clean cut. Sometimes the blades get sprung apart so that they leave a small sliver of the woody part of the stem. This will cause more damage than a long stem, as it is so sharp that it cuts into every lemon it touches.

Great loss by decay has been caused by permitting picked lemons to remain in the grove during a rain where the soil is badly infested with brown or cottony rot.

One of the most common mistakes in handling the boxes on and off the wagons is to allow a box to drop off the

cleat at one end of the box below and come down on the lemons, and then be pulled across before being picked up.

We use low, narrow wagons that are easily loaded and can be taken into the groves with little damage to the trees, and the lemons are taken directly to the packing house on these wagons, with but the one handling.

It is very important that the picking should be done at the right time, and the interval between pickings should be varied to suit the weather conditions at different times of the year. During the time of year when rains are apt to occur a special effort should be made to have the picking closely kept up.

Some growers have an idea that it pays to let the lemons grow large in order to get greater quantity, but this is [fol. 562] usually an economic waste, both in the growing and marketing, for the energy of the tree is expended in growing fruit that is of poorer keeping quality than that which is picked when the proper size, and it is also an off size that is not wanted, being sold at a discount. Pooling arrangements should pass this loss on to the grower who is responsible.

It is a mistake to leave small yellow ripe lemons on the tree, trying to force them up to the regular size at the expense of keeping quality; a small lemon that will keep may be worth something, but a full size lemon that will not is a liability.

I want to again emphasize the fact that all parts of the work should be so organized, that if anything occurs that tends to increase the decay of the fruit the blame can be immediately placed where it belongs.

Discussion of Decay in Lemons

By G. W. Hosford, Field Agent, California Fruit Growers Exchange, Los Angeles, California

Ladies and Gentlemen: I expected Mr. Willits to cover the subject, so I did not prepare a paper myself, but there are several things regarding the handling of lemons which I believe will bear repetition and double emphasis. I wish to say further that Mr. Willits has been in this business much longer than I and knows more about it. I think he has the name among lemon people of being one of the first

successful handlers of lemons. I have been very much impressed recently, going around in different packing houses and making observations to determine the amount of injury, in finding that in two houses the number that I counted, out of one thousand, in one case was one and in another two, and one of these was in Mr. Willits' house, so he not only knows how to handle lemons, but gets it done. That is the most important thing. Some of us know how to handle lemons but do not know how to get it done as well as we know how it should be done. It is absolutely essential we get it done correctly.

[fol. 563] I think there are one or two things Mr. Willits mentioned that need to be emphasized a little more, and one of these is the management of the picking of the fruit. The picking of the fruit when it has good keeping quality is one of the most important things in the successful handling of lemons without decay. I think it happens very often that the lemons are left on the tree to come to a certain size and sometimes not only a marketable size, but too large for marketing, and as a result the good quality of the fruit has been lost. I believe some of the most successful handlers of lemons, like the Limoneira people and others in that class, gain a great deal in the handling of their fruit by a practice of picking at the right time, not waiting for the fruit to get large at the loss of good quality. If the fruit becomes yellow and mature, even if it is small, it is picked. I think there is nothing so poor in the way of a lemon, as an overripe lemon. Small lemons that are fairly yellow have good keeping qualities, but if an oversized lemon is very ripe, it is almost impossible to handle same without some decay, some loss.

I think also the separation of the fruit for color when it comes into the packing house, the separation of that which is dark yellow and likely to be of poorest keeping quality, is one of the most important things. Some of the packing houses are inclinded to put in their good grades, on which they are trying to build a reputation, fruit which, while it may arrive in sound shape, has not the keeping quality by which it will be able to stand up until it reaches the consumer. It has not the keeping quality in the sense that it will keep long enough for the jobber to dispose of it to his trade, and I think too much care cannot be taken in seeing that the fruit put into the good grades is fruit

that has good, long-keeping quality. It is not enough that the fruit should arrive sound; it should also be able to hold up after it arrives on the market.

Another point of great importance is the question of how long fruit is held after it is picked. We can pick green [fol. 564] lemons in the early part of the winter and hold them six months without any great amount of decay. I have seen a great many lemons hold six months and some twelve months without a great amount of decay. I do not think that a great proportion of the lemons which can be held six months before they are marketed have keeping quality after getting on the market. It is too often assumed because the lemons have not shown any great decay in the packing house they can be marketed, and they will keep from that time on as well as in the packing house. After shipment the lemons are handled on the market under very different conditions from those in the packing house. They are up against harder conditions and may show decay under those conditions where they would not in a packing house. We had this well illustrated last year. As you know, our fruit was held last summer longer than usual, and we have never had as much decay showing in the market in California lemons in many years as we had during that period.

A lemon is not disposed of very quickly after getting to market, particularly in a western market. A man may buy a car of lemons and expect to be a month or two months before disposing of them, so it is the good keeping lemon, the lemon that will hold two or three months after the jobber gets it, that brings the money. The lemons held in California six months, or even three months, have not that keeping quality. So I think it is very wise wherever we can to ship fruit in as fresh a condition as possible. Our rule in San Dimas has been (we have not always been able to live up to it, but we always try to do so) not to hold ripe fruit longer than two weeks in the packing house; that which we have graded as silver tips not longer than a month to six weeks, and that which comes in green not longer than two months. There are cases in which it might be advisable to hold longer on account of the market, but in general we believe it would be better to ship even if the market is weak than to hold the fruit too long.

[fol. 565]. Careful handling of the fruit cannot be too much emphasized in the marketing of lemons, and while it is an old story, which has been repeated here a good many years and which is being followed more and more each year, yet I find there is still a good deal of injury resulting in the handling of lemons. At one place *place* I found thirty-five clipper cuts in one box. That is going to cause trouble. I found a case where the percentage of long stems was very heavy, and each long stem may injure several lemons. The lemon which has the long stem may not be injured itself, but it is what that lemon may do to the other fruit, and by the time it is delivered at the packing house that long-stemmed lemon, particularly if it is a sharp-pointed one, may injure half a dozen lemons. Eliminating the long stems at the packing house does little good, for the injury has already been done. The aim should be not to pick with long stems in the first place.

I find in a good many cases the operations are not checked up carefully enough. We have frequently put in a picking crew, assuming if it were a picking crew, it would do careful work, but that does not necessarily follow. I might say, however, that in all the fruit over which I have looked I have found much less injury from picking crews than from the individual grower's picking his own fruit. Not but what there are growers who pick their own fruit carefully, but we find a good many damaged lemons through carelessness, through poor clippers or through hiring two or three pickers whom they forget to watch. The great advantage of the picking gang is in having a competent foreman who is watching carefully so as to check up immediately and find out if a man is doing careless work. I found a case the other day where they said their picking foreman watched a box of fruit once in two weeks. I suggested that that was not often enough; that a foreman should know his pickers well, and if a man were careless in his picking, he should be watched every day. There are a good many picking foremen in the lemon work who would catch any, particularly rough work, [fol. 566] if a man were picking an hour, even if he had a good many pickers working for him. I believe I know many picking foremen, who if a new picker comes in, watch him closer than an old picker, and if he is inclined to be careless, they give him particular attention. If he is doing careless

work they will either see tht it is improved, or if he fails to improve, they will not keep him picking even one day. It is false economy, even when we are behind on picking, to keep a picker that will not do careful work. It is better to let him go and get one that will do careful work.

We found last year at San Dimas one contributory cause of decay in fruit. We had installed a tank at the end of the belt so that the lemons dropped into a bath of copper sulfate from which they were transferred to a box. We put in this arrangement because we thought it better to have the copper sulfate in a solution separate from the soap solution in the washing machine, because mixing the two renders each one less effective. We found, however, that the fruit which was handled in this way did not keep so well as that picked from the belt. The fruit was taken out of these tanks carefully, but it didn't dry quickly and so was a good deal wetter than if taken directly from the belt by hand, and it took considerable longer to dry after it had been stored. We immediately began checking certain of our lots handled that way, as compared with the same fruit picked off the belt, and we found we had considerable increase in decay in this fruit.

Further Discussion of Lemon Pruning

Mr. Shamel: Two of the photographs Mr. Fleet used have points of interest to everyone here aside from the pruning features.

The Chairman: Indicate the points.

Mr. Shamel: I would like to have Mr. Fleet do so.

Mr. Fleet: I wish to say that those trees, one being near the team yard where the teams come out and tramp the ground down considerably, are thirteen years old, and all [fol. 567] the care they have had in the last seven years or more has been water and a little manure around the roots. We keep records of each tree, and this tree here last year fourteen field boxes. Each field boxes averages forty-eight pounds.

PLAINTIFF'S EXHIBIT No. 35.

The Standard Cyclopedia of Horticulture, a Discussion, for the Amateur and the Professional and Commercial Grower, of the Kinds, Characteristics and Methods of Cultivation of the Species of Plants Grown in the Regions of the United States and Canada for Ornament, for Fancy, for Fruit and for Vegetables; with Keys to the Natural Families and Genera, Descriptions of the Horticultural Capabilities of the States and Provinces and Dependent Islands, and Sketches of Eminent Horticulturists.

By L. H. Bailey

Illustrated with Colored Plates, Four Thousand Engravings in the Text, and Ninety-six Full-page Cuts

In Six Volumes

Vol. VI. S Z and Supplement

Pages [illegible] Figs. [illegible]

New York: The Macmillan Company

London: Macmillan & Co., Ltd.

1917

The rights of reproduction and of translation are strictly reserved

Transportation of Horticultural Products

Commercially, fruits and vegetables are grown primarily for profit. Whether the business of fruit or vegetable [illegible] growing results in profit or in actual loss to the grower depends on a great many factors. Among the more important are quality and quantity of production, distance from markets, cost of transportation, the condition in which the produce reaches the markets, methods of marketing, and the supply and demand.

In present day fruit growing, especially where the localities of production are often thousands of miles distant from

the larger markets, there is no factor of greater importance than rapid and efficient transportation. Every fruit-grower is, or should be, aware of the necessity of safe and rapid transportation, together with the delivery of perishable produce at the markets in sound attractive condition. Soundness and freedom from decay or deterioration are fundamental to profitable marketing, therefore to successful fruit-growing. All the labor and moneys invested in production are wasted if the products cannot be transported and delivered in good condition.

Transportation is the link that connects the producer with his market, his zone of distribution being determined largely by the cost of transportation and absolutely by the distance over which the produce can be shipped in sound marketable condition. This distance will necessarily vary with the variety of fruit, the localities in which grown, cultural methods, care exercised in handling and preparing it for shipment, the promptness with which it is cooled, and the temperatures maintained in transit. The factors above mentioned are the more fundamental ones governing the condition of horticultural produce in transportation. It is clear, therefore, that successful transportation depends not only on conditions in transit but on the prehandling of the produce prior to shipment. The responsibility for the condition of these products when delivered at the markets is a common one as between producers, shippers, and carriers. The very best refrigeration that is practicable cannot be expected to deliver perishable products in sound merchandizing condition that have been badly handled [fol. 569] prior to loading or shipment. Nor can such produce properly handled be delivered in good marketable condition without adequate refrigeration in transit during warm weather or sufficient protection against freezing in the cold weather.

The railways of the United States annually pay out millions of dollars in claims on account of breakage, decay and deterioration, freezing, and other damage in transit of perishable produce. This does not begin to cover losses sustained by the shippers in claims that are not paid, or deterioration for which no claims are made, and the injurious effect on the price received for the produce actually sound. The economic losses to consumers, carriers, shippers, and producers, especially consumers and producers,

who finally shoulder the greater part of the burden, are enormous. This great wastage of the nation's food-supply is an important factor in the high cost of living and is very generally one of the main reasons for losses instead of profits to the growers or producers. The most important fact in this connection is that most of these losses are unnecessary and preventable. As the decay and consequent losses occur in transit, it is of the greatest importance that growers, shippers, and carriers have a clear and accurate knowledge of the fundamental factors governing condition of fruits and vegetables in transportation.

Few commodities are more subject to decay and deterioration in transit than are fruit and vegetable crops. In considering the transportation of these products and their behavior in transit, it is absolutely essential that the fact be kept in mind that fruit and vegetables are living organisms with a definite span of life beginning in the orchard or field and ending normally in actual death-decay. It must be remembered, therefore, that, in preparing these products for shipment, in transportation, and through all stages to the ultimate consumer, one is dealing with real organisms; the life-span of which will be lengthened or shortened by methods of handling and conditions in transportation. A [fol. 570] correct interpretation of the reasons for the losses from decay and deterioration in transit depends on accurate knowledge of types of troubles that destroy the market value of fruits and vegetables. The prevention of these losses must be based on a clear understanding as regards the relation of the development of these troubles to methods of handling prior to shipment, and to temperature conditions in transit. The types of troubles that may destroy or lessen the value of these products are of two kinds, decay and skin-blemishes. In ordinary transportation the former is by far of the most importance, while in storage skin-blemishes may be very important factors. Decay may result either from attacks by fungous or bacterial organisms, or through physiological breakdown which may be termed natural death decay. The organisms causing decay in transportation may for convenience be divided into two groups, those which are parasitic, or which may cause decay of sound uninjured fruits, and those which are saprophytic or which have not the power to attack the sound unbroken skin of fruits or vegetables. Para-

sitic fungi causing decay in transit are usually orchard or field diseases that ordinarily can be controlled through proper cultural sanitation practices in the fields or orchards. Saprophytic organisms are responsible for by far the largest proportion of losses due to fungous decay in transportation and can be controlled only through careful and correct handling methods in the harvesting and preparation of the fruit for shipment.

Physiological breakdown or death-decay hinges largely on proper handling methods and temperatures in transportation. It is plain, therefore, that the fundamental factors influencing, to the greatest extent, the behavior of fruits and vegetables in transportation come under the following heads: (1) Cultural; (2) maturity at time of picking; (3) care exercised in all handling operations; (4) promptness of cooling; precooling; (5) temperatures in transportation.

[fol. 571] Cultural History of the Crop

In so far as cultural practices determine the crop's freedom from disease when harvested and its inherent keeping quality, are cultural operations responsible for condition of these crops in transportation. Of especial importance are the methods of orchard or field sanitation. Field or orchard diseases attacking growing fruits or vegetables very often cause serious decay in transit. Peaches from orchards or sections affected with brown-rot (Scleratinia) or Monilia usually show serious development of brown-rot after shipment. In certain humid sections of the Pacific coast, for example, the prevalence of brown-rot makes long-distance shipment of cherries and fresh prunes an extremely hazardous venture. Certain vegetable crops, such as lettuce, celery, and tomatoes, when transported long distances, sometimes develop serious decay in transit through diseases that attack the growing crops in the fields. Decay in transportation, caused by diseases commonly affecting crops in field or orchards, can be controlled only through proper orchard- and field-sanitation practises. While the rapidity of the development of such decay in transportation can be controlled, to some extent, by quick prompt cooling and the maintenance of very low temperatures, the only real preventive lies in the control of these diseases in fields or orchards.

Maturity at Time of Harvesting

The picking-maturity of peaches, muskmelons, and other quick-ripening fruits is governed largely by the distance from market and general experience as regards the carrying quality of such fruits at different stages of maturity under ordinary refrigeration. When they are to be shipped for considerable distances, the usual practice is to pick and pack them while still so green, hard, and immature as to be unfit for immediate consumption. Sometimes they are harvested in such a green state that they do not properly ripen in transit, and while not entirely worthless from a marketing standpoint, their poor eating [fol. 572] quality necessarily results in very low prices. Fruits from certain sections have undeservedly gained a reputation for poor quality because the consumers never have had an opportunity to taste any properly matured fruit. There is no questioning the fact that if the quick-ripening fruits entering into long-distance transportation could be harvested at much nearer full maturity, that is, hard-ripe, and transported to the consumer in sound condition, both producer and consumer would benefit greatly, the former in increased returns, the latter in securing a more wholesome and palatable fruit.

The reason for the present condition is largely found in the notion that such fruits must be picked while still very green and hard to carry in sound condition to the market. To some extent this idea is well founded. Greater care, however, in all handling operations, with prompt cooling, will enable growers and shippers successfully to handle the quick-ripening fruits at more advanced stages of maturity. When precooling facilities are available, it has been demonstrated that it is not only possible but practicable to harvest such fruits as peaches and pineapples at advanced stages of maturity as will give the consumer a product possessing its maximum fine quality and wholesomeness. When such facilities are not available, much can be accomplished toward the same end through proper and careful handling, prompt loading, and the stowing of the load in the car in such a way as to facilitate circulation and consequent quick cooling or refrigeration. The practicability of successfully transporting more nearly tree- or plant-ripening fruits, possessing the maximum fine qual-

ity of the variety when delivered to the consumer, will depend both on the grower and the carrier. The grower must exercise, first of all, the greatest care in handling and get his fruit under refrigeration quickly. The carriers must provide refrigeration facilities in which the product can not only be cooled faster but transported at lower temperatures than is ordinarily obtained in the average equipment. What has been said above, relative to the desirability [fol. 573] of harvesting certain fruits at much advanced stages of maturity, does not, of course, apply to such fruits as pears, lemons, and fruits or vegetables which should be picked green in order that they may possess their maximum fine quality when finally ripened or cured.

Care in Harvesting and Handling

The care exercised in harvesting and preparing horticultural products for shipment determines, to the greatest degree, its shipping or keeping quality. Extensive investigations conducted on a commercial scale by the Bureau of Plant Industry, United States Department of Agriculture, for a number of years, covering a wide range of fruits and vegetables, have clearly and conclusively demonstrated that decay in transit and after arrival at the market is due very largely to rough methods of handling. The fungous organisms causing decay gain entrance through mechanical abrasions of the skin made in picking, hauling, packing, or other handling operations. Every injury or breakage of the cells of the skin offers lodgment for fungous spores which, given proper moisture and temperature conditions, germinate and produce decay. Both high temperatures and moist atmosphere favor rapid development and growth of these organisms. Temperatures are usually fairly high during the harvesting season, as is frequently the humidity. During periods of muggy or rainy weather, the conditions are ideal for the germination and development of fungous spores, and almost every injury is certain to result in decay. The fundamental consideration, therefore, in all handling operations is the preservation of the skin in a sound and unbroken condition.

Nearly all growers and handlers of fruit or vegetables realize that rough handling, resulting in mechanical abrasions of the skin, is more or less responsible for decay

occurring in transit. Few, however, have a clear idea of the extent of mechanical injuries made in ordinary com- [fol. 574] mercial handling, nor do they realize fully the importance of the most careful work, or what constitutes proper and careful handling of a perishable product. In a short article it is obviously impossible to go into details as to how injuries are made in handling from field to car. The handling operations involved in the harvesting and preparation of the citrous fruit crop for shipment may serve as a very good example. In the harvesting of citrous fruits the mechanical abrasions may result from cuts made by the clippers used in severing the fruits from the tree, from contact with thorns on the trees, from dropping the fruits into the picking sack or field box, rough handling in loading, and jarring in hauling over rough roads or on springless wagons. Additional injury may result as the fruit goes through the washing machines, brushes, and driers, and over the sizers, and into the bins. Long sharp stems also cause much injury as the fruits roll against one another in the picking sack, field box, and the various operations of washing, drying, grading, and sizing. The pickers and packers, where gloves are not worn, may cause much injury through finger nail cuts. The washing of fruit in dirty water, or slow and incomplete drying, both afford ideal or favorable conditions for infection of every injury and the consequent development of decay. The so-called soft fruits require even more careful handling to avoid bruising and to preserve the skin of the fruit in a sound unbroken condition through all the operations of picking, hauling, and packing. Peaches are very commonly injured through the pickers exerting too great pressure with the thumb or other fingers when removing the fruit from the tree, by rough handling in loading, and bruising in the various operations of grading and packing. While sizers or graders have been used to a considerable extent in the handling of peaches, most of the graders now in use afford too many opportunities for injury to be universally recommended in the handling of such crops. In red raspberries, for example, the most serious decay results from too great pressure on the berry when removing it from the core. [fol. 575] The use of three fingers instead of two minimizes the pressure and danger of injury. The inclusion of over-ripe berries in cups or crates intended for long-

distance shipment is also a very prolific source of decay. The marketing or distributing zone of such fruits and berries can be extended by several thousand miles by the exercise of a little more care in picking and grading. In grapes the most serious injuries result from the loosening of the berry from the pedicel, and it requires the most careful handling, both in picking and packing, to avoid this type of injury which is chiefly responsible for the frequent excessive decay occurring in transportation.

Careful handling involves the exercise of thoughtfulness in the manipulation of the fruit from tree to car in order to preserve the skin of the fruit in an unbroken sound condition. It necessitates the most careful supervision of labor. It means simple and the minimum amount of machinery for washing, drying, sizing or grading, and constant attention to keep it clean and in perfect order. The whole handling problem is an economic one related to systems of both hiring and supervising labor. In citrous states cooperative associations have found it necessary to take over the field handling as well as the packing house handling to insure uniformity of careful work. Where each grower does his own picking, the bad handling of one nullifies, to a large extent, the good work of the other, especially if the fruit from the different growers is pooled and shipped in the same cars. The success of this method of cooperative handling depends largely on having the right kind of manager and foreman, men who not only know what careful handling is and means, but who can secure such work from every man in the organization having anything to do with the physical handling of the fruit. The system of paying labor is largely responsible for carelessness in handling and decay in transit. Too much emphasis cannot be laid on quality as the tendency is at pres- [fol. 576] ent decidedly in the direction of attaching too much importance to quantity. Quantity at the expense of quality is poor economy in the handling of any perishable fruit crop. There is considerable question and argument as regards the best picking receptacle, particularly as to whether picking-sacks or -bags are preferable to pails or baskets or other similar containers. For citrous fruits,

and other hard thick-skinned deciduous fruits, canvas picking bags are usually preferable. Peaches and other thin-skinned fruits, that are very liable to injury by the rubbing of one fruit against another, ought to be picked in receptacles with rigid sides. In such receptacles the fruits will not be subjected to more or less rubbing against one another as they would be in a picking bag where every fruit necessarily moves somewhat with the movement of the picker.

Quickness and Promptness of Cooling

Next to care exercised in the physical handling of the fruit, temperature is the most important factor in determining the life span of the fruit. The question of temperature in the handling of fruits for transportation is related primarily to the promptness and rapidity with which the produce is cooled and the maintenance of low temperatures in transit. Most of the fruits and vegetables are harvested during periods of high temperatures. The physiological and chemical changes that constitute ripening proceed very rapidly at high temperatures and but very slowly at temperatures slightly above freezing. High temperatures shorten the life span of the fruit, both through rapid ripening and the rapid development and growth of decay-producing organisms. The low temperatures retard the ripening processes as well as the germination and growth of fungi causing decay. It is, therefore, of the greatest importance that the produce be cooled as promptly and quickly as possible after removal from the tree or field. Delay of a few hours of the more quick-ripening fruits after harvesting in the field or packing-house during the heat of the day may mean the shortening of the normal life-span [fol. 577] of such fruits by days. Prompt cooling is essential, whether this is accomplished by precooling before shipment or slower cooling in a refrigerator car. Advantage also may be taken of cool night temperatures by allowing the fruit to remain unpacked out in the open over night and packed later in the cool of the morning. More cooling can usually be accomplished this way over night than in a whole day in a refrigerator car, especially if the fruit is wrapped and tightly packed.

Precooling.

The prompt cold cooling of produce prior to shipment has been termed "precooling." It is usually accomplished by mechanical means in warehouse plants before loading in cars, or in car precooling plants after loading. In the latter case the precooling is accomplished by forcing large volumes of cold air through the load in the car. More recently smaller warehouse plants have been built and successfully operated using ice and salt for refrigeration. As to which system is the best is still more or less of an open question and depends largely on local conditions. Warehouse plants have the advantage in so far as the cooling of the produce can be commenced immediately after packing without any delay. The cooling is usually more uniform and very often the plants are used as warehouses to hold fruits and vegetables in good condition for considerable periods when, on account of market conditions, or for any other reason, it is desirable to do so. Mechanically cooled warehouse precooling plants are expensive to build and operate, and where the harvesting season is short, the benefits from precooling must be very marked to justify the expense. The salt and ice plants were designed to meet this objection and have proved very practicable where ice can be obtained at a reasonable cost and where the daily output does not exceed a few cars. The principal objection to car precooling plants are the delay between loading and precooling and the more or less unequal cooling of the different packages in the car. The delay incidental to finishing the loading of [fol. 57*] a car, and the switching to a precooling plant is sometimes considerable and in some instances the total delay may approximate, to some extent, the slow cooling under regular refrigeration. In a number of instances, where car precooling plants are in operation, in order to minimize delays, there is too much of a tendency to cut down the actual period of precooling, which results in partial precooling only. Some of the reasons why precooling is not more universally utilized may be found in the rather heavy initial investment necessary to build a plant, and the delay in shipment necessitated by holding over for precooling. Especially is this true with deciduous fruits, where, in many sections, the shipping season is short and where each ship-

per is desirous of getting his fruit or produce to the market as quickly as possible.

Precooling has been utilized more in connection with the handling and shipment of citrous fruits from California than anywhere else. It has apparently been found to be profitable in the citrous industry largely because of the long orange shipping season, and for the reason that it is utilized also to reduce the cost of transportation. Precooled fruit from the growers' warehouse plants is shipped with initial icing only during the winter and spring season, the combined cost of precooling and one icing being somewhat less than the regular refrigeration rate. In Florida, precooling of citrous fruits is more in the experimental stage, owing, however, to the short haul in warm territory in winter, precooled fruit is usually shipped successfully without any icing whatever. Comprehensive experimental precooling investigations on a commercial basis have shown decidedly favorable results from the thorough precooling of lettuce and celery from Florida. The principal berry-growing sections in California and Washington have utilized precooling for several years with the result that they have been able not only to transport berries, such as red raspberries and loganberries, in better and sounder condition, but to widen their marketing territory greatly.

(Vol. [illegible]) In a number of cases in which precooling has been tried on a commercial basis, the physical handling of the fruit has been too careless to result in any marked advantage from precooling. This serves to illustrate very forcibly that precooling should not be depended on to overcome difficulties arising from improper handling. Another factor of no little importance is the inability of the average refrigerator equipment to maintain sufficiently low temperatures, even under full icing, especially in the upper tiers, in transportation. The good effects of quick and prompt cooling have been nullified to a considerable extent by the rapid rise in temperature of fruits or produce while in transportation. No matter what system is employed, the full value cannot be obtained from precooling unless the produce has been properly and carefully handled in the first place. Used as a means to overcome the effect of rough handling, precooling only retards decay and deterioration and simply transfers the troubles from the first re-

[illegible] at the market to the retailer or consumer. [illegible] must be thorough and as uniform as possible. The refrigerator car used for the shipment of [illegible] should be sufficiently insulated to maintain reasonably low and uniform temperatures in transit.

Temperatures in Transit

The necessity for the maintenance of low temperatures in transit has already been emphasized. The question is often asked: How low ought the temperatures in a refrigerator car to be for best results? The only answer to this question is: As low as possible consistent with safety from freezing. The same principle applies as to storage. The lower the temperatures above actual freezing, the more effectively are ripening and the development and growth of decay producing organisms checked. While most of them continue to grow very slowly at temperatures of 40° F. or below, few germinate at this temperature. If [illegible] germination has already taken place, the best that can be expected of refrigeration is to check their growth and [illegible] [illegible] sufficiently to allow of sound delivery. The necessity for prompt and quick cooling is therefore very apparent.

The cooling of an ordinary refrigerator car is usually rather slow and very unequal. It requires from six days to a week thoroughly to cool a load of oranges in transit and several days to cool wrapped deciduous fruits. Unwrapped fruits in open containers cool relatively fast because of the opportunity for free air circulation around each individual fruit. The lower tiers cool relatively fast in any load, especially near the ice bunkers. There are marked differences in temperature between the ends and middle of the car, and between the top and bottom tiers. In the quick-ripening fruits these temperatures are reflected in the condition of the fruit in the various positions in the car. Very often the upper tiers are 15° to 20° higher in temperature than the bottom tiers and have ripened to such an extent as to make it necessary or desirable to sell them separately from the remainder of the fruit in the car.

One of the principal problems in transportation and refrigeration of fruits and vegetables in transit is to secure

regards shifting, breakage, and the like. The efficiency of the refrigerator car is primarily responsible for the quickness of cooling and the maintenance of uniformly low temperatures in transit as well as liability of freezing damage in cold weather. The efficiency of a refrigerator car depends not only on the quantity, quality, and condition of insulation but on the size of the car, the kind of ice-bunkers, and facilities for effecting free circulation and quick refrigeration of all packages in the car.

Salt, as a means of securing lower temperatures in refrigerator cars, is in use extensively in the transportation of meats and similar products requiring temperatures below freezing. It has been used only very sparingly with fruits. Recent tests with somewhat modified equipment indicate [fol. 582] that salt can be used to good advantage in securing quick cooling and in maintaining the necessary low temperatures in transit.

The methods of icing and charging for refrigeration in transit vary considerably in different sections of the country. From Pacific coast points to the East, the carriers, under certain blanket rates, assume all responsibility for refrigeration in transit from point of shipment to destination. In the deciduous fruit sections all cars, unless precooled, go out under standard refrigeration, that is, pre-icing before loading and full re-icing en route at all regular re-icing stations to destination. The refrigeration rate is uniform on all cars to any one point. Under the standard refrigeration rate for citrous fruits, the cars are usually not iced until after loading unless otherwise requested by the shipper who pays a somewhat higher rate for pre-iced cars. With citrous fruits from California, various other rates are in effect permitting one pre-icing and a re-icing before final shipment, or precooling, and one icing with no re-icing in transit. When the growers do their own precooling and initial icing with no re-icing in transit, a charge is made only for the use of the car and freight on the ice hauled in the bunkers. In the shipment of fruits from Florida there is not only the standard refrigeration rate which calls for full re-icing at the designated ising stations en route, but there is also another rate for half-icing, which means the refilling of the bunkers at the various icing stations to one-half of their capacity, the racks on the floors of the bunkers

being raised so as to hold the ice in the upper half of the bunker. In the eastern states the so-called blanket refrigeration rate to various points is not used to any considerable extent in the shipment of fruits and vegetables. The refrigeration charge to the shipper is usually based on the amount of ice consumed in transit as shown by the carriers' records at icing stations. The shipper pays for the ice actually used and the icing is done according to the instructions furnished by him on the bill of lading. If the shipper [fol. 583] orders full refrigeration in transit, the cars are re-iced at the regular icing stations. The shipper, however, has the option of giving other instructions if he so desires, namely, either the number of icings en route or the icing stations at which he wishes the cars to be re-iced. Under the standard refrigeration rates, applying from the Pacific coast territory, the responsibility for refrigeration in transit rests entirely with the carriers. In eastern territory the responsibility is divided between the shipper and the carrier.

Freezing in Transit

The transportation of fruits and vegetables in sound condition in transportation is related not only to efficiency of refrigeration but to protection against freezing. During protracted periods of cold weather, such as sometimes occur in the northern and eastern states in the winter, the protection of fruits and vegetables in transit is a real problem. While a number of factors enter into the question of freezing protection in transit, the principal one is insulation. Aside from condition and quantity of insulation, shippers and carriers have both attempted to minimize the danger from freezing by heavy tight loading and lining the inside with heavy paper, sometimes using several thicknesses, by putting in floor racks and by placing stoves in the bunkers or in the middle of the car.

Both tight and heavy loading are desirable when there is danger from freezing. The tight load tends to hold the heat more effectively and the heavier the load the more heat there is to draw on. Lining with heavy building-paper, or other paper of similar character, gives added protection. Certain roads have found floor racks of decided value in minimizing the damage from freezing. Results both experimentally and commercially fully justify their use to min-

imize frost damage as well as an aid to more effective refrigeration. The use of stoves or heaters is hardly to be commended, as frequently the injuries from overheating certain parts of the car result in deterioration as regards [fol. 584] quality, condition, and appearance that exceed what the freezing damage would have been. In the transportation of potatoes during the colder months from northern states such as Maine, heater cars are used to a considerable extent. Ordinary freight cars with specially constructed bins so as to provide an air-space between floor and sides of car and the load are used very largely also. A stove is placed in the middle of the car and a messenger accompanies three, four, or more cars to keep the fires going properly. The heat from heaters either outside or inside the cars is depended on more than the insulation to maintain temperatures above freezing.—H. J. Ramsey.

Trapa (abbreviated from calcitrapa, which is the same as caltrops, an instrument of war used to impede the progress of mounted warriors; it had four spine-like projections, like the fruit of the water caltrops). Trapàceæ or Hydrocaryàceæ; by some retained in Onagràceæ. Floating plants adapted to the aquarium.

Flowers small, axillary, solitary, short-peduncled; calyx 4-parted, the segms. persistent, sometimes spinescent; petals and stamens 4; ovary 2-loculed; ovules solitary, long, pendulous, affixed to the septum: fr. top-shaped, leathery or somewhat bony, 1-loculed, 1-seeded.—Three species, native to the warmer parts of the eastern hemisphere.

Trapa natans is one of the daintiest aquatics in cultivation. It is perfectly hardy and very desirable for aquaria, pools, ponds, or tub-culture. Its beautifully mottled or variegated foliage is very attractive. The flowers are white, small, and inconspicuous. The fruits are very large in comparison with the flowers and leaves, but they are hidden beneath the foliage until they ripen, when they drop off. They are good to eat raw, like chestnuts, and are sweeter and more palatable before the shell becomes hard. The nut is not likely to become of commercial importance in America. The seeds drop from the plant and remain in the pond all winter. Seeds must be kept in water or moist to retain their vitality. (William Tricker.)

[fol. 585] natans, Linn. Water Chestnut. Water Caltrops. Jesuits-Nut. Petiole of floating lvs. 2-4 in. long, nearly glabrous; blade rhombic-orbicular, dentate in upper half, slightly villous along the nerves beneath: fr. 4-spined, but the 2 lateral ones shorter. Eu., Orient. Gn. 24, p. 557. G.C. II. 10:213. B.R. 259.—It has two kinds of lvs. The submerged ones are root-like, long, slender, and feathery. The floating lvs. form a loose rosette. The lf-stalks are swollen and spongy near the apex. The fr. is an inch or two across and has 4 spinescent angles. It is roasted and eaten in some parts of Eu. like the common chestnut. It is sparingly.

PLAINTIFFS' EXHIBIT No. 36

Vol. II. October, 1917. No. 1

The Quarterly Bulletin of the State Plant Board of Florida

Contents

	Page
The Roll of Honor	1
Some Florida Scale-Insects	2
Control of Scale-Insects	66
Sweet Potato Root Weevil	81
Citrus Canker Report	100
Port and Railway Inspection Report	101
Parcel Post Plant Inspection Report	103
The Pineapple Black Weevil	103
Editoral	104

Published by State Plant Board of Florida, Gainesville, Fla.

Entered as second-class matter November 14, 1916, at the postoffice at Gainesville, Florida, under the Act of June 6, 1900.

The Cuban Aschersonia. Aschersonia cubensis is probably more or less widely distributed in Florida, but was [fol. 586] only recently (March, 1917) distinguished from A. turbinata. The identification was made by Dr. Thaxter, courtesy of A. T. Speare of the Bureau of Entomology, U. S. D. A. This fungus is not unlike the turbinate fungus, but,

instead of a single or branched whitish stalk, it consists of a low dome about the size of, or larger than, the insect that it infects. Over the top and sides of this dome are a number of small cavities filled with the reddish or yellowish spores of the fungus.

It has so far been positively identified infecting the liriodendron scale and the palm, or tessellated scale, but it is believed that one or two others of the so-called soft scales may be hosts.

Some Contact Insecticides Employed Against Scale Insects

Yothers' Formulas.—These formulas were devised by Mr. W. W. Yothers, Field Agent of the Bureau of Entomology, U. S. Dept. of Agriculture, stationed at Orlando, Fla., and were intended primarily for spraying the whitefly, but they are also excellent for spraying all kinds of scale-insects. The formulas are simple and no heat is necessary, except for the last one, in order to get the ingredients to combine.

Mix 2 gallons soft fish-oil soap and 1 gallon water.

To this mixture of soap and water, slowly add 3 gallons Diamond Paraffine, Junior Red Engine or other lubricating oil, 24 to 28 degrees Baume, at the same time stirring the mixture vigorously, or pumping it back into itself several times until all the oil is emulsified.

The product is the stock solution which has a thick cream-like consistency. For spraying citrus trees, dilute stock solution at the rate of one gallon to 50, 60, 70, 80, 90, or even 100 gallons of water. For spraying during May, through summer and early fall, use the mixtures, 1 in 70, 80, 90, or 100. For late fall, winter, and early spring, the stronger mixtures, 1 in 50 or 60. For spraying dormant deciduous trees without foliage, the mixture may be used as strong as [fol. 587] 1 in 10. On deciduous trees in foliage, and other tender plants the mixture should be used very weak, and even then it is best to first experiment on a few plants.

Mr. Yothers also devised the following formula, which contains less soap and is cheaper, but requires more stirring to prepare the stock solution.

Fish-oil soap, 1 gallon.

Water, 1 gallon.

Oil as previously indicated, 2 gallons.

Prepare and dilute for spraying as indicated in the first formula.

Yothers' "New Formula" contains still less soap, but requires heat in its preparation. The proportions of the ingredients are as follows:

Fish-oil soap, or laundry soap, 2 lbs.

Water to make 4 gallons of stock solution, about 1¾ gals.

Oil as in the other Yothers' formulas, 2 gals.

This mixture must be heated to the boiling point, preferably over an open fire in order to avoid accidents of fire to buildings, and then agitated as directed in the first formula, for spraying, it is diluted as directed for the first formula.

Any other kind of soap can probably be substituted for the fish-oil soap in all of these formulas, but hard soap must first be dissolved in hot water.

If the water to be used for diluting the stock solution is hard, so that free oil rises to the surface when some of the stock solution is added to it, it will be necessary to first soften it by adding soap until it begins to lather and feel decidedly slick to the hands.

Lye, washing soda and borax are sometimes recommended for softening water, but are not always reliable because they do not neutralize all water-hardening minerals.

Proprietary Miscible Oils and Emulsions.—There are several of these on the market that give excellent results, but like the Yothers' formulas, if hard water causes free oil to rise to the surface, this must first be softened by the [fol. 588] addition of soap. One to four pounds of soap to 50 gallons of water will generally be found sufficient.

Soaps.—Soap solutions are very good insecticides. While fish-oil or whale-oil soap is generally recommended and used, *and* any other soap may be just as good. The writer has used laundry soap successfully. When there are only a few trees or plants to be sprayed, a few bars of laundry soap, always available, may be used. One pound of soap to five or six gallons of water will be found strong enough during periods of warm weather,—in May, through the summer, and early fall. For spraying scales and whiteflies during the late fall, winter and early spring, or dur-

ing the cooler parts of the year, one pound of soap to three or four gallons of water may be used. There

---

PLAINTIFFS' EXHIBIT No. 37

The Quarterly Bulletin, State Plant Board of Florida

Vol. II. July, 1918. No. 4

The Theory and Practice of Sanitary Precautions in Grove and Packing-house Operations

John C. Holton, Assistant General Inspector, State Plant Board

Part 1

Theory of Sanitary Precautions

During the time the writer has been in Florida, he has become convinced that a considerable amount of improvement can be made in the methods of handling both our citrus groves and citrus fruits, in order that the industry may not only be more thoroughly protected against injurious insects and diseases but also that the crop may reach the market in better condition and consequently bring a better price to the grower. What it is desired to bring to the [fol. 589] attention of the reader in this article is the question of more sanitary methods in the handling of grove properties and the handling of the crop. The principle involved is not a new one by any means, but has been recognized by the Citrus Exchange and a number of independent packers, by most of the leading growers of the State, and by the authorities who have given close study to all phases of citrus production. For example, a bulletin upon "The Diseases of Citrus Fruits," under the authorship of Professors P. H. Rolfs, H. S. Fawcett and B. F. Floyd, published by the University of Florida Experiment Station in November, 1911, summarizes as two cardinal principles in reducing citrus fruit diseases, the following points: "Some of these troubles can be overcome only by better grove sanitation and hygiene." "Wherever possible a dis-

ease should be prevented rather than allowed to occur." It is doubtful of more eminent authorities on the subject of citrus diseases in Florida than those just quoted could be found.

The employment of sanitary methods has a quadruple bearing upon the industry. They have to do, first, with the improvement of the condition in which Florida citrus fruit reaches the market; second, with preventing the spread of diseases and insects from one grove to another and from one locality to another; third, their effect in facilitating the final eradication of citrus canker from the State; and, finally, protection of the industry against the spread of diseases which may be introduced into the State, accidentally, of course, in future years. We would prefer to discuss these under separate heads.

1. Many of our readers may have had the same experience as the writer when visiting fruit markets in northern states. Florida citrus fruit can usually be distinguished from all other fruit at a distance of several hundred feet, simply because it does not present a bright, clean appearance, and it is only the man who has found out by experience the excellent quality of what is inside of the rind of the Florida fruit who is the habitual buyer. It seems to us that the time is here when systematic effort [fol. 590] should be made to improve the appearance of the Florida fruit, thus enabling it the better to hold its own in competition with citrus fruit from other sections of the United States. Insects and diseases are the principal causes of the discolored and unsightly condition of much Florida fruit that is shipped to the North. While it is true that this condition cannot be remedied without bringing about a more satisfactory control of the insects and diseases now in our groves, it is also true that steps should be taken to prevent aggravation of the present condition, which will undoubtedly result if we permit more and more insects and diseases to enter our groves.

There is also the question of decay and loss of fruit in transit. A consignment of fruit free from decay will bring a uniformly higher price than a shipment consisting of sound and decayed fruit together. In other words, loss from decay in transit is not alone loss of the fruit which is decayed, but the general price of the remaining fruit

is lowered. The time was when approximately ten per cent of the Florida fruit shipped to the North was lost through decay and mould. Through the educational campaign conducted by the Florida Experiment Station for the past few years and as the result of better packing and packing house methods, particularly more careful handling of the fruit than formerly, this loss has been greatly reduced. On the whole, taking into consideration all shipments and not comparing with another, it is likely that the loss from these causes will in the neighborhood of ten per cent. Assuming that the normal crop of Florida is 6,000,000 boxes and that the grower receives an average price of $2.00 per box, a loss of five per cent means an annual loss of $600,000.00 on the Florida crop. It has been reliably informed that a number of growers and packers, through the adoption of better methods in handling the crop and in packing, have succeeded in reducing this percentage of loss to approximately one per cent. That even this small loss can be reduced by still further improvement in the methods of handling the crop is perhaps self evident. From a purely financial standpoint, [fol. 501] therefore, the adoption of these methods by growers cannot result otherwise than in increased profits to the grower.

Among the causes for damage and deterioration of fruit in transit may be mentioned several fungous diseases, the most important of which is usually the blue mold. The term "blue mold" is applied to the damage by one or more fungi which are closely related. The distinction between these fungi need not be discussed at the present time, for their action is practically the same and the methods of dealing with them are the same. The spores of these fungi enter the fruit through slight cuts, wounds in texture of the rind, or through injuries made by other diseases and after entering the fruit their increase and growth cause rotting decay. The spores of blue mold are quite generally distributed through groves and packing houses, their relative number being very largely dependent upon the measures employed to dispose of moldy fruits and to prevent contamination of clean fruit by moldy fruit. In experiments made by the Florida Experiment Station several years ago, the great importance of preventing injuries through which these fungi could enter the fruit was clearly

established, and as a result of these experiments much better methods of handling the fruit to protect it from injury have come into vogue generally throughout the State. If the fruit could be handled from the tree to the market without clipper cuts, injuries or bruises, there would be no loss due to blue mold for there would be no way in which the blue mold fungus could gain access to the interior of the sound fruit. Care in handling is therefore of the utmost importance, but one hundred per cent efficiency in this regard cannot be secure. Therefore, if this care is avoid injury to the fruit be supplemented by thorough cleanliness in the packing house and by the use of disinfectants to destroy fungus spores in field boxes, washing tanks and packing houses, a still greater reduction of loss from this source will inevitably follow. As illustrating this, we may cite the case of one packing house (No. 58) in which the loss from blue mold of fruit enroute to market averaged from two to five per cent. Measures of cleanliness in the packing house were adopted, field boxes were scrubbed once a week with soap and water and at the same time more care was employed in the handling of the fruit between the grove and the packing house. The result was that the loss from blue mold was reduced to one per cent. This reduction was brought about purely by cleanliness and without the use of disinfectants. How much more then would the loss have been reduced, perhaps to a point inappreciable, had disinfectants been used along with the cleaning work to destroy the blue mold spores?

In a recent conference with Professor P. H. Rolfs, Director of the Florida Experiment Station, regarding this matter, Professor Rolfs expressed the opinion that in reducing the loss from blue mold, dipping of field boxes in a disinfecting solution would be of the first importance, cleanliness of second importance and care in handling the fruit, third. However, all of these matters go hand in hand and a combination of them should practically eliminate losses from blue mold. In fact, Professor Rolfs has stated that careful handling and absence of clipper cuts, coupled with sanitary disinfecting measures and cleanliness, should reduce the average loss by blue mold to less than one per cent.

Another cause of the decay in citrus fruits enroute to market is the stem-end rot, which is caused by the same

fungus that produces anthracnose on the leaves. The form of the fungus which grows in dead wood produces spores which are responsible for stem-end rot and also for the anthracnose form of the disease appearing on the leaves. The fungus is not able to penetrate green fruits but does penetrate to the fruit stems. Owing to the damage to trees by the cold weather during the past two years, malnutrition is unusually abundant this year, and should weather conditions be favorable to the development during the picking season, we may this year expect an unusually large amount of stem-end rot. We are now able to recommend [fol. 50] measures which are a complete panacea for all troubles to which citrus fruits are heir, and it must be frankly admitted that the dipping of field boxes in disinfecting solutions will probably have no effect in preventing the development of stem-end rot between packing house and market. This is true for the reason that the fruits are in most cases already infected with the disease when they come to the packing house. It is true, however, that in the grove the fungus can enter the stem of the fruit where the latter is removed by the clippers, and the fungus causing stem-end rot can make its way through at least three inches of twig from the clipped cut to the fruit itself. A stronger argument could not be adduced to show the value of keeping the clippers disinfected when removing the fruit from the trees. This is only another application of the sanitary, antiseptic idea.

Anthracnose to a small extent develops on fruit enroute. The anthracnose spots on the rind sink in if conditions are cool and moist and these spots afford entrance for the blue mold fungus.

Nail-head rust is caused by the same fungus which causes scaly bark, usually in the presence of the withertip fungus. It is doubtful if the nail-head rust markings continue their development in transit, but these nail-head spots afford entrance for the blue mold. It will be noted, therefore, that the entire question, in so far as decay of the fruit is concerned, is a complicated one in which several different diseases take part and that some of these diseases are agencies through which other diseases may accomplish their nefarious work. Aside from those mentioned, which are quite familiar to all citrus growers, it is advisable to take into account other fungi that are present in the State

and should be kept in subjugation as much as possible for the reason that they may at some future time become more virulent and hence more destructive than they are now. Such a disease is the Diplodia rot. This fungus is present in Florida in considerable amount but does not apparently cause much fruit rot. Like other plant diseases this disease might increase in virulence and become of first rank among those responsible for these losses.

Aside from the question of thorough cleanliness, we might say that the dipping of field boxes after each lot of fruit is emptied, using a suitable disinfectant for the purpose, prevents contamination from one lot of fruit to another and protects fruit from clean groves when this fruit is hauled in boxes previously used in groves where these diseases are prevalent. Of course disinfecting of field box is but one step in keeping down these diseases, and it is proper to suggest also the use of some disinfectant in the water used for washing fruit, such, for example, as using one (1) per cent of bluestone in water for the washing, or adding one fourth of a pound (¼ lb.) of permanganate of potash to one hundred gallons of the wash water. It would also appear advisable, in the light of our knowledge regarding these molds and decays, to make rather liberal use of a disinfecting solution in sprinkling the packing house floors prior to sweeping. Sprinkling of floors to keep down dust is in common practice, but the use of a disinfecting solution to destroy the fungus spores would be an added benefit. For this purpose could be used formaldehyde, one part of 40% formaldehyde to 90 parts of water, a 5% solution of carbolic acid, or a 2% solution of bluestone.

2. Field boxes and field equipment are among the most effective agencies for spreading diseases and insects from one grove to another and from one neighborhood to another. Scaly bark, prior to the adoption of the quarantine rules by the Plant Board, was spread to many neighborhoods in Florida, and in many of these cases the evidence available indicates quite conclusively that the introduction was due to the use of ladders that had previously been used in groves infected with scaly bark. Incidentally, has

it ever occurred to the reader that the picking ladder is perhaps the most diabolically complete apparatus that could be devised for infecting trees with any fungus or bacterial disease which enters through abrasions of the bark? The field box is a potent agency in spreading scale-insects and [fol. 595] white flies of the different species. All scale-insects in their early stages are tiny crawling lice. They can live without food for several hours, and some of them for several days, so when they are placed in a field box with fruit from an infested tree they can remain in that box until the box is emptied and sent to a grove somewhere else. Cottony cushion scale particularly is readily distributed in field boxes. Thus far we have found eighty-seven species or kinds of scale-insects in Florida and of these twenty-nine kinds attack citrus. All of these in one grove would make fruit from that grove absolutely unmarketable, yet all of them are gradually spreading under present methods of handling the groves and crops and ultimately the majority of them will be in each and every grove unless better methods are adopted to prevent their general dissemination. Distribution of both diseases and scale-insects through the agency of field equipment, and particularly ladders, bags and field boxes, can be practically prevented if these things be disinfected at proper intervals.

3. In relation to the eradication of citrus canker, we believe it can safely be said that the turning point towards victory has been reached. In all there have been 478 properties in the State which have been found infected with this disease. The Plant Board has already declared as no longer danger centers 432 of them, or 90%. This declaration by the Board is equivalent to stating that in the opinion of the Board canker has been eradicated from these properties. There are still 46 properties in the State classed as infected, and if we could be sure that there are no infections in the State other than those we have discovered and that we have under quarantine, we could almost guarantee that eradication of the disease would be completed within the next two years. However, there may be other infections that we have not discovered. The reader will naturally ask why we have not inspected all of the citrus properties in the State to find out whether

they are infected. There are over 10,000,000 citrus trees in the groves of Florida, and to make one inspection of [fol. 596] them with the largest force of inspectors we have ever had would require several years' time. The truth of the matter is that it has taken nearly all of our available funds and nearly all of our inspectors to stamp out the infections which have been discovered, and it is only as we make more and more progress in cleaning up these centers of infection that we have any inspectors available to undertake the advance or scout inspection of areas not hitherto inspected.

We also know that we have never been able to secure a complete record of all the citrus trees that were shipped from canker-infected nurseries. Some of the shipments that escaped us, and which we have never been able to locate, may be somewhere in Florida today with citrus canker on them. There are several possible ways in which infection may have become established without out finding out about it. Trees may have been sneaked into the State from infected localities in the baggage of individuals, or in the earlier days infected fruit may have been shipped to different parts of Florida.

The point we wish to impress upon the reader is, that if any such undiscovered infections are in existence, spread of canker is taking place from them almost daily by reason of laborers, teams, fruit buyers and others entering those properties and then going to other properties. Unless we adopt and put into practice everywhere methods which will stop the spread of canker from the undiscovered infection, we do not know how long it will be until we complete the eradication of canker. The only way the grower can protect himself against the undiscovered infection is to so handle his property that citrus canker cannot get into it, no matter from what source or in what way it may come. This means, of course, the employment of sanitary precautions in the handling of his grove property, and the sooner the growers in general adopt these measures the sooner will the eradiction of canker be completed and money saved, not only to the fruit grower but to the general taxpayers throughout the State.

[fol. 597] 4. Many of our groves are veritable zoological gardens and pathological museums in the variety and num-

ber of insects and fungus diseases present therein. It is, nevertheless, a fact that there are many destructive insects and diseases which we do not yet have. If any of these are accidentally introduced in the future despite all of the quarantine work of the State authorities, they will spread just as diseases have spread in the past unless the growers take measures to forestall them. The brown rot fungus is not known to be in Florida, but if it should ever be introduced it would be difficult for the growers to detect its presence because of its close similarity in the gummosis from to bank diseases of citrus which we already have. The disease might easily attain a wide distribution before its dangerous nature is recognized and special steps taken to suppress it. A disease such as this, which may cause a loss of 25% of the fruit enroute to market, is to be guarded against in every way possible.

In Jamaica, Cuba, the Panama Canal Zone, and the Bahamas is an insect known as the spiny citrus white fly, or black fly, closely related to our own white fly but many times more destructive. There is every reason for believing that under Florida conditions it would be as serious a menace as citrus canker. It does not confine itself to citrus trees, however, but is destructive to the mango, guava, sapote, and many other trees. Of course we are trying to keep it out and will continue to try to keep it out to the utmost of our ability and resources, but should it by any chance get into any citrus grove in Florida the field box would, under present conditions, immediately become the means of spreading it from grove to grove and from county to county. The use of sanitary precautions and the disinfection of field equipment is, therefore, good insurance against the wholesale distribution of pests and diseases which threaten us from the outside, and which when they do get into Florida will be in and at work before their presence is discovered.

[fol. 598] Part 2

Practice of Sanitary Precautions

On October 8, 1917, the State Plant Board passed its Rule 36 covering the subject of disinfection of field boxes used in public fruit packing houses. This rule was later

amended. On June 10, 1918, the Board suspended the operation of Rule 36 for the period of one year. The Board, in taking this latter action, did so as a war measure, feeling that with the existing shortage of labor, the use of any large number of men in any horticultural activity which does not directly and immediately result in increased production of food crops is unwise. The application of the instructions issued under the provisions of Rule 36 would require the employment in the packing houses of the State of Florida of perhaps several hundred men, and since the benefits accruing from the disinfection of field boxes can hardly be regarded as immediately and directly influencing food crop production and the services of these several hundred men can be used to greater advantage in other ways, such as in shipbuilding, munition making, planting, cultivating and harvesting food crops, the Board took the action above referred to and suspended the operation of the rule, at the same time reiterating its belief in the efficacy of sanitary precautions in packing house operations as a means of preventing the spread of diseases and insect enemies of fruit trees and urging all packing house operators to make use of the prescribed means when practicable to do so.

It seems desirable, therefore, at this time and following the action of the Board, to give to the fruit-growing public and to the interested packing house operators, as briefly as possible, the results of the observations made and the experience gained in the actual application of the measures advocated.

The reasons why sanitary precautions should be practiced in field and packing house operations have been set forth so clearly and concisely in the section devoted to the Theory of Sanitary Precautions, that it seems hardly necessary to [fol. 599] dwell further on this subject. However, it may be of interest to refer to the conception of the idea which later developed into the present rather complete plan of grove sanitation, and to briefly follow the growth and development of this idea. Like many other things which eventually amount to something, the origin of the plan of using sanitary precautions, that is, precautions by cleanliness to prevent injury to trees and products, goes back to the period when damage to trees was first caused by diseases and pests.

The Evolution of the Idea of Sanitary Precautions

In the earlier history of horticulture, no doubt man attempted to combat the ravages of diseases and pests by crude efforts along the line of prevention. In more recent years, the knowledge that diseases of trees were often caused by micro-organisms led to the use of methods of treatment looking not only to cure, but prevention. Frequently methods of treatment were used which were effective, and no doubt the method was given credit for curing, whereas the cure was effected by the removal of the diseased part, and the prevention of recurrence and of further spread was the result of the application of the "cure" or "remedy".

The idea of preventive treatment of diseases and pests in orchards has, without much blare of trumpet, kept up with other progressive movements in modern science, and the practical horticulturist has not been slow to accept and use the suggestions made from time to time by those engaged in research work. Here in Florida the citrus fruit grower has for many years been making use of methods in his grove operations which, while not recognized as such, were in reality the rudiments of what is now rather commonly referred to as "sanitary precautions in grove operations". The greatest advance in the direction of grove sanitation has been made during the past few years, and the reason for the progress is without question directly traceable to a calamity—the introduction of citrus canker [fol. 600] into Florida. The introduction of this disease which threatened the citrus industry with destruction, and the eradication of which has for four years been the one big thing in the minds of the citrus growers of Florida, was little short of a disaster. The actual money loss incident to the introduction of citrus canker, if it were possible to compute it with any degree of accuracy, would doubtless run into many millions of dollars if we included, in addition to the cost of the eradication campaign and the destruction of trees, the depreciation of property values in many sections of the citrus-producing area. Yet this very disaster has served to bring the growers of Florida into a closer relation with each other, was the cause in great measure of the enactment by the Legislature of an adequate and, in many respects, a model horticultural law, and has re-

sulted in many other benefits to the fruit industry. Not the least of these benefits is the higher development of the idea of grove sanitation and the creation of a healthy sentiment in support of this idea. At the risk of repeating what is perhaps a familiar story to many, it may be well at this time to go somewhat into detail as to the growth and development of the idea of sanitary precautions covering the period of the past several years.

In the summer of 1914 the citrus growers in South Florida were themselves handling the campaign to eradicate citrus canker, the disease not having been known to exist at that time anywhere in the State except Dade County. There seemed to be very little progress made. It was noted that whenever an infected property was found by inspectors, upon reinspection additional trees were found infected. This happened no matter how carefully the property was inspected the first time. It must be remembered that there was very little known about citrus canker. In fact, at this time there had been no public announcement made that the disease was caused by a micro-organism. However, when the laboratory investigations disclosed the fact that the disease was caused by an organism, this, in connection with the fact that cankered trees had been so frequently [fol. 601] found in large numbers on inspections made subsequent to visits by inspectors, led many of the thinking growers to the conclusion that the inspectors and owners were themselves carrying canker. As an evolution of this thought, efforts were made to so disinfect the inspectors as to prevent the carriage of the disease. These efforts were at first very crude indeed, consisting of the use of a small hand spray, such as is used by amateur gardeners, for spraying the inspectors' clothing, especially the lower extremities and shoes, with a solution of vichloride of mercury. With time the idea of the thorough disinfection of the inspectors' clothing developed further, and with increased knowledge derived from both field and laboratory investigations it was finally determined that the only proper course to pursue was to treat the inspectors who visited infected as well as non-infected groves very much as though they were surgeons or nurses entering an operating room for the purpose of performing an operation. In other words, when an inspector entered a citrus property he was perfectly clean so far as disinfection of this outer clothing was

concerned. This result was obtained by means of his wearing a one-piece suit which had previously been dipped in a solution of bichloride of mercury, a head covering similarly dipped, and leggings and shoes which had been disinfected. The disinfection was even carried to such an extent that the hands, face and neck of the inspector were bathed in the bichloride solution. Inspectors were not allowed to touch the trees when possible to avoid doing so. It is significant to note that, with the adoption of these methods of personal cleanliness, or disinfection, in conjunction with the immediate destruction of trees when found to be infected, begins the period when we made some headway against the inroads of citrus canker.

Another evolution of the same idea of disinfection evidenced itself in the restrictions which were placed upon the operations conducted in infected properties. All work [fol. 602] done in properties which were found infected with citrus canker was done under certain precautions which were prescribed by representatives of the State Plant Board. Workmen were required to be as particular and as careful in the disinfection of their clothing as were the inspectors themselves and all tools, vehicles and other equipment used in the infected property were thoroughly disinfected. It may be well said that the successful eradication of citrus canker is dependent upon careful inspection, destruction of diseased trees immediately when found, personal disinfection of inspectors and workmen, and the conduct of the work in infected properties in a sanitary manner. Practically all operations in groves and nurseries where infected trees are found are carried on for long periods under such precautionary measures as outlined above, and when an individual, horse, or mule leaves such properties he is thoroughly disinfected.

Disinfection of Field Boxes

Among other measures made use of in the eradication campaign was the requirement that owners of citrus canker infected properties must immerse in an antiseptic solution all field boxes used in picking fruit and also that all public packing house operators in the vicinity of infected properties should follow the same practice. We are confident that this procedure has contributed in a great measure in pre-

venting further distribution of citrus canker. As a material evolution of all of the above practices, that is, of the disinfection of equipment, of individuals and field boxes to prevent the spread of citrus canker, the thought occurred to many of the more progressive growers of the State and to the staff of the State Plant Board, that if such practices were beneficial as applied to citrus canker, why would they not be equally so if applied in an effort to prevent the spread of other diseases caused by organisms? And why not also practice these methods to prevent distribution of injurious insects? This feeling among the more progressive growers of the State has, during the past two years, developed and [fol. 603] grown to such an extent that the disinfection of field boxes and other equipment is now strongly advocated and is being practiced by many growers and packing house operators. This advocacy primarily of course being for the purpose of preventing the distribution of citrus canker from any undiscovered foci; at the same time it seems now to be a well recognized fact among growers and packing house operators that diseases of various kinds and insect pests affecting fruit trees may, in great measure, be prevented from being distributed if field and packing house equipment are disinfected.

The various agents of the State Plant Board, stationed in different sections of the State, from time to time reported to the Gainesville office the growth of this sentiment. The Plant Commissioner's office was in receipt of many letters from prominent growers in the State advocating the use of sanitary precautions in grove operations, many growers requesting that a rule be passed by the Board which would require the disinfection of field and packing house equipment, more especially such packing house equipment as was used by the public packing houses, the danger in this particular instance being regarded as especially great on account of the wide distribution which field boxes used in public packing houses usually attained. After a thorough canvas of the situation it seemed advisable to the Executive Staff of the Plant Commissioner's office to recommend to the Plant Board, the adoption of a rule covering this subject and the Plant Board, after very careful consideration of the information submitted to it, acceded to what appeared to be a very strong demand on the part of the growers of the State and enacted Rule 36.

Application of Sanitary Measures in Packing House Operations

Under the provisions of Rule 36 the Plant Commissioner issued certain instructions requiring that all public packing houses engaged in packing citrus fruit install suitable dipping vats or other apparatus for the purpose of disinfecting [fol. 604] by immersion in a disinfecting solution, each and every field box in which fruit is brought to such packing house. The Plant Commissioner also prescribed certain disinfecting solutions, the chief of which was a solution of bichloride of mercury at a strength of 1 to 1000.

As previously mentioned, Rule 36 was formulated and passed by the Board in response to a general demand on the part of the growers of the State for some action along this line, and as a result of observations made throughout the State by the Plant Commissioner and his assistants as to the practical operation of certain precautionary measures in use in communities where citrus canker has been prevalent and which measures were instituted for the purpose of preventing the possible distribution of this particular disease.

Since the passage of Rule 36 this office has received many commendatory expressions and assurances of earnest cooperation from growers and packers in various parts of the citrus belt. The consensus of opinion among growers seems to be that in the passage of this rule the Plant Board made a very long stride indeed in the direction of further protecting the citrus industry.

In some quarters the impression has prevailed that the disinfection of field boxes involved the use of complicated apparatus and machinery, the use of considerable extra labor and the incurring of quite an additional expense to the packing house operators. This impression is wrong. It was and is suggested that packers confine their installations to as simple and inexpensive apparatus as possible for the present. As a result of the experience obtained during the first season of operation, the operator will be in better position to determine his requirements and the nature of the outfit best adapted to his use. No doubt the use of conveyors, belting, diverters and other apparatus will ultimately prove advantageous. Perhaps some packing house operators will even at this time know their needs

to such an extent that they can at once extend their equipment to meet the new demands, thus being able to more [fol. 605] efficiently and economically handle the dipping of field boxes. It must be remembered, however, that the arrangement of packing houses is by no means uniform. It is impossible for the Plant Commissioner's office to give advice or information which would apply to all packing houses as to the arrangement of any equipment which the instructions in regard to the disinfection of field boxes may require. The problem in connection therewith must of necessity be solved in accordance with the arrangement of the present packing house equipment.

The simplest device suggested for the disinfection of field boxes consists of a cypress vat or tank 7½ feet long, 3 feet wide and 2½ feet deep, located close to the place where fruit is received and dumped, with a drain board of the same width as the vat placed at one end of the vat and slightly inclined so that the excess solution may drain back into the tank after the field boxes are dipped and placed on the drain board. When possible, this vat or tank is located at the side of the dump so that the man operating the dump can also immerse the field box, which in many instances eliminates the services of an extra laborer. As has been found by experience, the truck man hauling in filled boxes to the dump man can at the same time remove the empties on his return trip. The Plant Commissioner, in a letter of instructions addressed to all packing house operators of the State last season, made the above suggestion and it apparently met with the approval of a large percent of the operators. The size and shape of the dipping vat is of minor importance. The wooden vat seems to be preferable to the metal vat and is more generally used. Among the more recent improvements on dipping vats is an outfit devised by the manager of the Winter Haven Citrus Growers' Association, which consists of a box made of wood mounted on low wheels so that it can be moved from one place to another in the packing house. One concern manufacturing packing house equipment has constructed a mechanical device for the disinfection of field boxes. This was used in several packing houses last season with apparently good results. [fol. 606] There are many operators in the State who have given much study to this subject, and doubtless in the near

future the packers of the State will be offered a device more economical and practical than anything yet devised.

Cost, etc., of Disinfecting Field Boxes

As the packing season of 1917 and 1918 was drawing to a close, after Rule 36 had been in operation for some time, it was decided by the Plant Commissioner and his assistants to procure first-hand information from the packing house operators themselves in order to ascertain how the practical application of the instructions issued under Rule 36 was working. To accomplish this object, representatives of the Plant Board called upon the packing house operators in their respective districts and presented a series of questions pertaining to the season's operations. There are on file in the office at Gainesville the names of 414 individuals, firms or corporations listed as operators of packing houses in the State. We have received definite reports from 166 of these packing houses. Of the 414 packing houses listed, approximately 200 operated during the season of 1917 and 1918. Many of the packing houses were not operated last season, as the fruit crop was greatly reduced in some sections as a result of the cold spells of 1917 and 1918. The results as tabulated from the 166 reports received are very gratifying. These reports were from packing houses operating in 18 of the 24 citrus producing counties of the State. As stated, 166 packing houses made reports. Of those reporting, 81, or practically 50%, complied fully with the instructions issued under Rule 36. The vast majority of the operators from whom reports were received endorsed the idea of sanitary precautions in packing operations. Sixteen operators expressed disapproval. Others were non-committal. We note further that 24 operators who had not previously done so signified their intention to install dipping vats before the opening of the packing season of 1918-1919.

[fol. 607] A few packing house operators have advanced two objections which are worthy of note, namely, that of cost and of supposed damage to the field boxes by reason of dipping them in the disinfectant. The matter of cost must of course be given due consideration, although experience has shown that the cost of operating under sanitary

precautions is so little as to be hardly worth considering. The figures given in this article are authentic, having been obtained from packing houses that actually installed dipping vats and disinfected field boxes last season. One of the most striking reports that has been called to our attention comes from Mr. J. B. Booth, manager of the Tavares Exchange packing house, which packing house made use of sanitary precautions in their entirety throughout the season of 1916-17, as well as the season of 1917-18. It has been found that the added cost of immersing field boxes in bichloride solution in the Tavares house is ¼ cent per packed box and the total cost covering disinfection of all field equipment, including boxes, bags, ladders, clippers and the one-piece suits worn by pickers is about 2/3 of a cent per box. From the reports sent in by the District Inspectors of the Plant Board, after calling on the packing house operators in person, we find that of the 49 operators who made reports as to the cost of dipping field boxes last season, 37 report the cost as not exceeding $5.00 per 1000 boxes or ½ cent per box or less. The total cost of dipping field boxes ranges from $12.50 per 1000 to $1.60 per 1000 boxes. The lowest figures submitted were received from Mr. D. H. Duggins, manager of the Ozona Citrus Growers' Association, where a mechanical device was used to disinfect the field boxes. There are other packinghouse operators, though, who have also reduced the cost to a very low figure. The report of Mr. F. B. Rainey, manager of the Ft. Green packing house, shows the remarkably low cost of $2.00 per 1000, or 1/5 cent per box. Mr. L. B. Skinner of Dunedin, Florida, reports that the total cost of disinfecting field boxes last season in his packing house was $2.35 [fol. 608] per 1000 boxes, or a trifle more than 1/5 cent per box. A general average of cost based on the forty-nine reports filed by the packing house operators, previously referred to in this article, representing nearly every citrus growing county in the State, is $5.00 per 1000 or ½ cent per box. These figures came from all kinds of packing houses ranging from the smallest to the largest, with no uniformity as to size, shape or equipment. It is interesting to note that the lowest figures submitted come from operators who have installed some mechanical device. Most operators dipped by hand and the cost was in every case

greater, using the same disinfectant, than where a mechanical device was used. A number of operators when called upon to furnish an estimate of the cost of disinfection replied that the cost was too small to be accurately estimated. We think that it is a safe conclusion that the cost of using all sanitary measures advocated in packing and handling citrus fruits will not exceed one cent per box of packed fruit.

Deterioration of Equipment

There is practically no deterioration of the metal parts of the boxes on account of dipping in a bichloride solution. Our observation has been that field boxes which were repeatedly dipped at packing houses over the State last season show that the boxes are in no worse condition on the average than similar boxes which were not dipped. For the purpose of determining the effect of the corrosive sublimate solution (1 part to 1000) used in dipping boxes, several experiments were conducted here in the office at Gainesville. Metal stripping dipped in the solution every third day for three months, and both stripping and cement nails dipped four times daily for three weeks were discolored but showed no marked corrosion. In neither of the above tests was any appreciable injury noticeable. In fact, several months after the above experiments were conducted, the same pieces of metal that were used previously are now being dipped as before and hung in the open where the sun and air can gain access to the metal, and still show no appreciable injury.

[fol. 609] The conclusion is that both from experience in the packing house and the office tests the deterioration is so slight that it is hardly worth considering.

Disinfecting Solution

As to the solution best adapted to the disinfection of field boxes and field equipment nothing better has so far been found than bichloride of mercury, of a strength of 1-1000. This strength is obtained by the addition of eighty grains of commercial bichloride to each gallon of water, or one pound to ninety-eight gallons of water. This is the solu-

tion advocated by the Plant Commissioner and is in general use throughout the State. Other solutions have been used but bichloride of mercury is tthe best. Even though bichloride of mercury is an efficient germicide, one of the strongest known, and its use will most certainly destroy disease germs and prevent distribution of diseases, yet it must be admitted that it is not a very strong insecticide. In fact there is not known at this time any single chemical or substance or combination which possesses equal value as an insecticide and germicide and which would be suitable for disinfecting packing house equipment. For the time being it seems that bichloride of mercury is the best material that can be made use of for disinfecting field and packing house equipment.

State and Federal authorities are now, and have been, working to find a solution to this problem, that is, to find a combination of chemicals which will combine insecticidal and germicidal properties to such a degree as to insure the destruction of disease-causing organisms and also of mature and immature injurious insects. Such a combination to be of practical value must be one which will be cheap, easily obtained and used, harmless to boxes and other equipment as well as to the hands of the users. Considerable progress has been made in this work. It is hoped that in a comparatively short time announcement can be made of the results of these investigations.

It may be of interest to readers of this article to know that with the advancement of the idea of sanitary precau- [fol. 610] tions in grove operations horticulturists of other states have become very much interested in the progress being made in Florida along these lines and it will not be surprising if, after it has been fully demonstrated that the use of these precautions is a practicable thing, other states and other communities will adopt their use. The Federal Government is working in very close cooperation with the State of Florida along these lines, and is watching with the closest attention the progress that is being made and the results obtained.

PLAINTIFF'S EXHIBIT No. 38

July, 1920. The California Citrograph. 285

The Sunkist Courier Department

The success of cooperation lies not so much in cooperation itself as in the individual

Compiled Monthly in the Offices of the California Fruit Growers Exchange

Crusade Astir to Improve Methods of Fruit Handling—Association Men Meet—Discuss Field Problems

General Manager Powell tells hundreds to better packing-house standards in view of rising costs. Local meetings scheduled throughout citrus belt.

The need of improving upon present field and packing house methods in order to eliminate decay in the fruit was presented by General Manager G. Harold Powell at a mass meeting of several hundred Exchange association managers, directors, packing house and field foremen held in Los Angeles last Wednesday afternoon. This message was received with keen interest by those present, who were [fol. 611] requested to bring the facts 'home'' to their packing house and field forces at the earliest possible moment.

Mr. Powell reviewed the status of the citrus industry fifteen years ago, when the losses from decay through improper methods of handling the fruit was estimated at five hundred thousand dollars to one and one-half million dollars annually. He showed that the most common form of decay in oranges and lemons is caused by blue mold, a fungus which does not have the power of attacking a healthy fruit but which attacks fruits that have been injured mechanically by clipper cuts, gravel or stem punctures, by packing house machinery or by Wither Tip or any other disease; and that only by overcoming these difficulties can the fruit be shipped to eastern markets without loss and be handled by the trade without excessive decay.

The speaker brought out the fact that there had been a deterioration in the industry methods since the beginning of the war, because of shortage of labor and the difficulty of applying the most efficient methods to the different operations. He showed, however, that there are associations in every district that have handled all of their picking and packing in such manner as to insure the sound arrival of their product in eastern markets, and also that such organizations return to their growers the highest f. o. b. prices.

There has been a great increase in the cost of production, in labor, in transportation and in other items of overhead expense. These increasing costs have taxed the industry severely and no association can afford to permit its fruit to be handled in such a way as to cause losses from decay, when many of these losses are preventable and can be eliminated by the proper organizing of the field and packing house forces.

Mr. Powell brought out the fact that, under present conditions, some of our associations might be eliminated, unless they were able to overcome the preventable losses which are [fol. 612] due to the bad condition of their fruit on arrival in the markets, because the fruit will not bring back the cost of production.

He outlined the methods of organizing the picking, grading, packing and other handling of the fruit so as to preserve the inherent fine keeping quality of California oranges and lemons, and thereby bring back to the industry a very much larger return. He presented forcefully to the meeting the fact that there must be a revival among the growers in the appreciation of the need of the most careful methods of handling the fruit; that the growers must support their packing house management in steps necessary to accomplish this end; and that if the packing house manager is not able to organize his forces properly, a change should be made and a more efficient man put in his place.

The speaker showed from bulletins isused by the Department of Agriculture when the decay of oranges was under investigation years ago, that sound oranges and lemons are not subject to the usual forms of decay unless the skin is mechanically injured in picking or packing. He there-

fore insisted that the prevention of decay is under human control and that the picking and packing house operations must be organized around careful handling methods.

Arrangements were made to call meetings in different districts to devise ways and means of applying these suggestions.

[fol. 613] PLAINTIFF'S EXHIBIT No. 39

Volume IX, Number 9

Monthly Bulletin of the Department of Agriculture, State of California

Sacramento, California, September, 1920

Decay in Citrus Fruits During Transportation

By O. F. Burger,[1] Washington, D. C.

Introductory

In most fruit it takes fifty-one weeks to produce the crop and in one week it is marketed. In this one week fifty-one times more care should be taken than in any one of the previous weeks. However, here is where many producers fail—they take less care during the process of marketing their fruit than they do in growing it.

Classification of Citrus Fruit Diseases

After working on the markets for some time it became apparent that the old classification of fungi as parasites and saprophytes did not meet the demands of the business men. We therefore attempted to classify the diseases in three categories:

1. Diseases which cause damage in the field and in the field only.

---

[1] Pathologist, Fruit Disease Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

2. Diseases which cause damage in the field, and which are able to develop or spread during the process of marketing.

3. Diseases which occur during the process of marketing and may be induced by the methods of marketing.

[fol. 614] Citrus Fruit Diseases Defined

When we speak of disease we mean anything on the fruit which is abnormal and which to the merchant is a defect and adversely affects the selling price of the product.

In the first category are included such defects and diseases as thrip injury, scale, anthacnose, tear-staining, scab, melanose, thorn injury, fumigation injury and tree scars. Fruits with these characteristics are usually packed in the lower grades but may sometimes be packed in the better grades. When this kind of fruit is placed in the better grades, either by mistake or on purpose, then the Food Products Service may be called upon for an inspection. These defects are not the ones which have given the most trouble, for the worst have been discarded in the packing house.

In the second class belong the treacherous citrus diseases, those which cause decay. They develop during the process of marketing and are of gravest concern to the grower and buyer. The following are the most common of these diseases: Stem-end rot, brown rot, gray-mold rot, alternaria rot and cottony rot. It is plainly apparent that these are troubles of the growers. All California shippers know the great losses they sustained a few years ago form brown rot. Not only did apparently sound lemons decay on the way to market, but lemons decayed on the trees and the trees themselves were affected with gummosis. Very little need be said of the other troubles with the exception of stem-end rot.

The Fungus Phomopsis Citri

In 1909 Prof. H. S. Fawcett found that the fungus Phomopsis citri was causing a great loss to the Florida citrus grower. It was noticed that a heavy dropping of fruit occurred and that all the dropped fruit began to decay at the stem end. In fruit affected with this disease,

softening of peel and underlying pulp begins almost invariably at the stem end and extends rapidly until the whole fruit is involved. In the early stages there is little or no [fol. 615] discoloration, but soon a light brown discoloration is apparent. The rot progresses rapidly down the central axis, and usually reaches the blossom end by this route sooner than through the surface peel. There is sometimes a tendency to extend in the peel most rapidly along the lines marking the divisions between the fruit segments. At ordinary temperatures the rot may extend an inch a day, requiring four or five days to completely rot the fruit. The fruit does not shrivel or lose its shape unless subjected to pressure. Fruit which has been allowed to remain under the tree for some time becomes covered with a grayish colored fungus.

Isolations from freshly-fallen fruit showed that the fungus was the same as that on the outside of the old decayed fruit. Sound fruit inoculated with pure cultures of this fungus decayed in like manner as those in the field. Thus it was established that Phomopsis citri was a cause of stem-end rot of citrus fruits.

At this same time considerable decay was occurring during transit which could not be explained. Decayed and affected specimens were sent to the Florida station from the northern markets and the same fungus again was isolated. Those fruits had been packed in apparently sound condition, but on their arrival at the market were found decayed. From certain groves losses as high as 75 per cent were sustained. It was found that some fruit began to decay five weeks after shipment.

Shipping Experiments

Some shipping experiments were conducted in cooperation with the United States Department of Agriculture (Bureau of Markets). It was found in a certain shipment on arrival in Washington there was a 1.5 per cent loss.

One week after arrival, 8.5 per cent decay.

Two weeks after arrival, 22.3 per cent decay.

Three weeks after arrival, 36.7 per cent decay.

[fol. 616] Evidence seems to point to the fact that the fruit was infected at the time of shipping.

Dipping of field boxes in disinfecting solutions seemed to have no effect on the percentage of decay, for the reason

stated above that the fruit was already infected when picked.

Stem-end Rot Develops in Transit

One of the great troubles with the selling of citrus products is that on account of stem-end rot the buyer does not know what he is getting. This fungus develops on the way to market to such an extent that the loss runs as high as 50 per cent. Therefore the buyer must take this fact into consideration and buy on a margin so that he is protected. The grower and not the buyer is the loser. Therefore, it should be emphasized that the work on stem-end rot needs vigorous prosecution. This disease is getting worse each year, and until a control is found the losses will be great.

There were only one hundred inspections of citrus fruits asked for up to January 1, 1919, last season. This does not mean that only one hundred cars arriving on the market showed stem-end rot, but it does mean that there was a dispute over adjustment of the losses occurring in one hundred cars of fruit. Therefore the United States department inspector was called in to give a third opinion. About the middle of October stem-end rot showed up worse; 42 per cent of the fruit examined show the disease. At the middle of November there was a 28 per cent loss. The amount kept on decreasing until the first of January, when there was no stem-end rot showing up in cars for which inspection was asked. An average of 24 per cent of stem-end rot was found in cars inspected up to January 1. This disease kept appearing on the market throughout the year, but there was more decay before January 1 than after that date.

Fruit may be picked and packed that shows no signs of decay, yet, when it arrives on the market, a goodly per cent has decayed. This is the reason so many growers [fol. 617] do not believe the receivers when the latter state that a certain per cent is affected with stem-end rot.

How to Ship

All fruit should be packed as quickly as possible and precooled or shipped out under refrigeration so as to check the growth of the fungus. The stem-end rot fungus grows

best at about 80°. If the fruit is already infected when it enters the cars refrigeration will not stop the growth of the fungus, but will only check or slow down its growth.

Lemon Decay Due to Phomopsis citri

During the 1919-20 season, while investigating the decay of citrus fruits on the market, stem-end rot was found on California lemons. Cultures made from decaying lemons showed the fungus to be Phomopsis citri (Fawcett). This is the first time that this fungus has been found in California citrus fruits. Immediately the inspectors were asked to keep a lookout for this rot on California lemons. Specimens were sent in from Chicago, New York, Philadelphia and Washington, D. C. These lemons came from the Santa Barbara district. We immediately informed the California Citrus Station of our find and asked them to send someone to that region to investigate the situation. Prof. Fawcett went to the Santa Barbara district and found the disease in the field. Lemons decay in the same manner as described for stem-end rot of oranges from Florida. He states that he found the fruiting bodies of what appeared to be the same fungus on the dead and dying twigs. It behooves each grower, therefore, to keep a strict watch for this disease and take measures to stamp it out of his grove as soon as found.

Methods Advised for Florida

1. Prune out all dead and diseased twigs and limbs.
2. Destroy old fruit.
3. Cull and carefully handle all fruit.

[fol. 618] 4. Cool the fruit as quickly as possible, and keep it cool.

Preparing California Lemons for Market

In California the great loss in some packing houses may be due to the methods used in preparing lemons for the market. This disease probably has been taken for brown rot or gray mold rot.

Since, as Fawcett says in his Florida Bulletin, "the evidence at hand indicates that in actual practice most of the

germs of decay are in the fruit at time of picking," we can only expect increasing losses during the transportation if the fungus should spread to other groves in California not now affected. It also is the grower's duty to see that his groves are free from this disease.

Blue Mold of Citrus

The third class of diseases is that which arises during the process of transportation and marketing, and are induced by these methods. Blue mold of citrus has caused more loss in the past to the citrus industry than any other one disease. This fungus develops from a small spore, but is unable to penetrate the sound skin. The first stage of the decay is a softening at the point where the fungus has entered the fruit. This is always found to be at some injury or puncture. It never appears on a perfectly sound and uninjured orange.

In Bulletin 123 of the United States Department of Agriculture, Mr. G. Harold Powell states, on page 20, speaking of the blue mold decay:

"The causes of the decay were not understood, but a multitude of theories were advanced by growers and shippers to explain it. Some attributed the decay to the influence of the type of soil and to other conditions under which the fruit was grown; to a possible degeneracy in the fruit as the trees grew older, and to climatic conditions, such as frequent fogs and rains. The decay was thought by many to be especially related to a supposed inherent weakness of the fruit during the blooming period of the [fol. 619] trees, which occurs during the picking season. Others believed it to be due to the methods practiced in the packing houses, while nearly all were more or less agreed that a large part of the loss was chargeable to inadequate or improperly handled transportation facilities. The decay entailed a heavy loss on the shipper, it was detrimental to the reputation of the industry, and it led to difficulties of various kinds between all parties concerned in the handling and transportation of citrus fruits."

On page 22, speaking of the kind of wounds on fruit which might be possible places for infection of blue mold, Mr. Powell says:

"The effect of different kinds of cuts and abrasions on the fruit appeared important. A slight puncture or the removal of bits of the epidermis by scratches or by shaving it with the picking shears would frequently dry before spores could germinate and become established. A deeper wound, especially in the body of the fruit, where the skin is thin, would usually fill with juice and provide an ideal condition for rapid decay. It was noticed that decay did not develop in these slight wounds, while it was almost sure to develop in the deeper wounds unless the fruit was held in an unusually dry or cold atmosphere."

On the same page he says:

"Without puncturing the skin, the mold spores were placed on the surface of oranges which had been delivered at the packing house in the usual commercial way and were apparently sound. This fruit was held for one or two weeks in the house, where conditions were favorable for the germination of the spores and for the development of decay, and then examined. It was rare to find that decay had developed at the point where the blue mold had been placed on the fruit. Decay, however, sometimes developed where no mechanical injuries were visible. In these cases the mold probably entered the skin through injuries caused by the punctures of insects, by the dropping of the fruit or through other injuries not discernible."

[fol. 620] In Bulletin No. 108 from the Florida Agricultural Station, Prof. Fawcett says that blue mold can largely be prevented by extreme care in picking, handling and packing, since it follows injuries to the fruit.

In Bulletin No. 262 of the University of California, on page 187, Prof. Fawcett says, speaking of the blue mold:

"These fungi are apparently unable to enter except through imperfections or injuries of the skin of the fruit. It has been found by many experiments that a large part of this decay may be avoided by the careful picking, packing and shipping of fruits."

In the quarterly bulletin of the State Board of Florida, Vol. 2, No. 4, on page 163, the author of the article states:

"If the fruit could be handled from the tree to the market without clipper cuts, injuries or bruises there would be no loss due to blue mold, for there would be no way in which the blue mold fungus could gain access in the sound fruit." He suggested in the article the remedies for blue mold, such as cleanliness in packing houses, scrubbing of boxes once a week with soap and water and more cere in handling the fruit between the grove and the packing house.

In a pamphlet issued by the California Fruit Growers' Exchange, March 1, 1917, written by Pratt, on page 14, is found the statement, "Blue mold can only attack the fruit through injuries of some sort; it can not rot a perfectly sound orange or lemon,"

The power of the fungus to grow in healthy oranges in commercial cold storage has been tested by inoculating fresh fruits with the mold spores in a puncture through the epidermis and placing them at once in a temperature of 32° F. or less. Decay had not developed in two months, when the test ended.

In Bulletin No. 63 of the United States Department of Agriculture, A. V. Stubenrauch and H. J. Ramsey, pomologists, with a corps of workers, have recorded experiments which they conducted in the handling and shipping of Florida oranges. On pages 38 and 39 they show diagrams for the handling of fruit. On page 39 there is a diagram which [fol. 621] shows that one house lost 59.5 per cent of a certain shipment by its careless handling. When careful handling methods were used they lost only .7 of 1 per cent of the fruit. In another house a loss of 5.7 per cent of fruit was sustained, but by careful handling this was reduced to 2.7 per cent.

On page 48 they make the following statement:

"More than 90 experimental shipments of oranges were made from Florida in 1910-11, and 65 were sent out in 1911-12, including fruit from every section of the state and from good, poor and average houses. The carefully picked, graded and packed fruit showed 35.6 per cent and the commercially handled fruit had 65.9 per cent. After one week these had increased to 4 per cent, 46 per cent and 71.6 per cent, respectively; after two weeks they were 11.5 per cent,

54 per cent and 72.2 per cent; and after three weeks, 11.5 per cent, 57.1 per cent and 72.2 per cent.

"The carefully handled fruit arrived in Washington during both seasons with less than 1 per cent of decay, or an average for the two years of 0.6 per cent for all the experimental shipments. The fruit handled under commercial conditions throughout had developed more than twice as much decay by the first inspection as occurred in the carefully handled fruit at the end of three weeks."

While in Florida last October the writer delivered a lecture at the Citrus Seminary of the University of Florida and heard Mr. Stewart, one of the citrus exchange men, make the statement that Florida had improved in its handling methods by the work of Mr. Ramsey, but since that time they had backslid and were beginning to handle their fruit more carelessly than they had during Mr. Ramsey's active work in Florida. I am well aware of the fact that during the fall of 1918 and during the shipping season of 1919 there has been a great deal of decay due to blue mold and this, I believe, is due to improper handling in the field.

[fol. 622] Summary

The writer has tried to show that the two great diseases of citrus fruits, arriving on the market, are stem-end rot and blue mold decay. Stem-end rot is a field disease. The fruit is infected in the field, and it is the duty of the grower to stamp it out of his groves. If fruit arrives on the market decayed and all precautions were taken during transportation the grower is the loser. Railroad companies and commission merchants are asking for the truth so that claims can be adjusted. These concerns are awake and show signs of active campaigns in methods of disease control.

In the case of blue mold it has shown that it is due to careless handling. If cars have been properly handled during transportation and decay begins, the railroad companies are not responsible and they are fighting claims for loss in such cases.

If the product arrives on the market in an unsightly, decaying mass, it sells as such. The good fruit is sold at a lower price on account of the decayed fruit in the same boxes.

PLAINTIFFS' EXHIBIT No. 40

The California Citrograph, a Monthly Publication Devoted to the Interests of the Citrus Industry and to the Promotion of Subtropical Agriculture

March, 1921, Vol. VI, No. V

Need of Care to Prevent Blue-Mold Decay in Transit

By H. J. Ramsey, Field Manager Calif. Fruit Growers Exchange

There is no other factor that will so greatly influence the returns of our growers and our associations as that of decay. We cannot urge too strongly the necessity of taking every precaution to prevent decay, both in transit and after [fol. 623] arrival on the market. During the past few weeks many shipments from Southern California have shown decay of from 5% to 15%, meaning actual losses to the shippers of from 50c to $1.50 per box. With our present costs of production, packing and transportation, losses of from 50c to $1.50 a box oftentimes mean that our shipments will not bring more than handling and transportation charges, in fact, frequently less. Under these conditions it is absolutely essential that each and every shipper analyze thoroughly his local problem with a view of reducing to a minimum the decay in transit.

The decay which has been reported to date has all of it been Blue Mold Decay, due to injury of some kind, either mechanical injuries made in preparing the fruit for shipment, or worm injuries, of which we have more than our share in some districts.

Field Handling

As reported in our last circular of the 29th ultimo, a survey of handling conditions by our Field Inspectors (the data based on inspection of the work of 30 associations and 77 crews) showed that we are getting, on the average, defective picking to the extent of 8.8%. 5.8% of this defective picking is directly chargeable to long and slanting stems; 1.6% to clipper cuts, and the remainder, 1.4%, to miscellaneous injury such as gravel, twigs, etc. In this connection

we want to again emphasize the necessity of certain fundamentals in securing proper field handling and of making possible the delivery of the fruit to the packing house in good, sound condition.

Supervision

Proper supervision and inspection of the picking is necessary on the part of each crew of each association. The supervision is obviously up to the foreman of the gang, and the character of work obtained is fundamentally dependent upon the foreman's ability to handle men, his realization of what careful handling means and the most careful attention [fol. 624] on his part to every detail of handling. The inspection can be, and is, handled in various ways, oftentimes by the foreman of the gang. He, however, has so many other duties to perform that it is often impossible for him to inspect the work as carefully as he should. The inspection of the picking in many associations, therefore, is lodged in one man, a picking inspector, who has nothing else to do but to thoroughly inspect the picking of each man in each crew. Where the right kind of man is obtained for this work he can render the association invaluable service through careful inspection of the work of each picker and by working with the pickers, bring their work in each instance up to a satisfactory standard. Under present labor conditions if certain pickers do not show either ability or inclination to bring their work up to standard, such men may very profitably be eliminated. In some districts the district exchanges employ the inspector who inspects the picking of each crew in each association. This has worked out very well, particularly in districts where the territory is not too large and where they have been fortunate enough to get the right kind of a man as inspector.

Clippers

Aside from the care exercised by the pickers to avoid mechanical injury, the condition of the clippers has a good deal to do with the kind of work obtained. In the first place the pickers should be supplied with the kind of clippers that have been demonstrated to give the most satisfactory results; that is, clippers that are fool proof, to the extent that this is possible. The foreman should at all times see

that the clippers are in A-1 condition, and that poor clipping is not the result of defective or poorly adjusted tools.

Picking Boxes

The closest attention should be given to keeping all picking boxes in thorough repair. Many of the picking boxes, especially the older ones, are more or less broken, have [fol. 625] many splinters and protruding nails which cause considerable mechanical injury and consequent decay. Care should also be taken that they are not so full that when loaded on the wagons or trucks the weight of the boxes will rest on the fruit instead of on the ends of each box as they should. Many field boxes are made of shook full of knots. As these knots fall out, jagged sharp points are left which cause much injury. Every association can well afford to throw these out for repair.

Injuries in the Packing House

Whenever the machinery is not in use, the equipment should be gone over thoroughly with a view to seeing that it is in first-class condition. In a number of cases thorough examination of the machinery has revealed the fact that much mechanical injury has resulted from protruding nails or splinters that would not ordinarily be observed unless the machinery is carefully gone over from time to time.

Packing

Both graders and packers, of course, should be provided with gloves in order to prevent finger nail injury. In unpacking a number of boxes lately we have found, particularly where very high packs are being put out and due care is not exercised at the press, a number of oranges are injured when the covers are being put on. In some cases we have found as many as eight oranges with the skin broken in one box of the 200 size.

Worm Injury

In certain districts much of our fruit is coming in showing considerable worm injury. The result of this type of injury is reflected very clearly in the decay reported in cars

shipped from these districts. While we realize that it is extremely difficult to eliminate all of this in grading, every precaution should be taken by putting on extra graders to eliminate the worm injured fruit. While it adds somewhat to the cost of handling, certainly a few extra graders will not cost anywhere near as much as a loss of $1 or more per [fol. 626] box on shipments of fruit where worm injury is prevalent. Many of our houses are putting on sometimes as many as three times the number of graders usually required, and if by so doing they can catch most of the worm injured fruit, it will more than repay the shipper.

In some districts the fruit shows decay on the trees as a result of worm injury. This decayed fruit is picked with the sound. Oftentimes a field box of fruit will have as much as a half dozen decayed oranges. Unless this decayed fruit is picked out at the dump, the entire machinery (brushes, dryers, etc.) will become thoroughly infected and every injured orange will almost certainly decay. These decayed oranges must be culled out before they go through the machinery, otherwise serious decay is a certainty in all lots of fruit run through it.

Soft Creased Fruit

In some districts we are getting decay because of soft and creased fruit. Many lots have been observed where the fruit is so soft and creased that the packing of it without it splitting and breaking is an impossibility. Every precaution must be taken to cull this out of the fruit being packed for shipment.

Brown Rot

Following the recent rains more or less brown rot is showing up in different districts. The fungus which causes the brown rot is extremely contagious, spreading rapidly by contact to adjoining fruit in the packed boxes. The wash water, however, is the most prolific source of infection, unless Blue Stone or some other disinfectant is used. To prevent infection of sound, unaffected fruit, Blue Stone should be used in the wash water in the soaking tanks in the following porportions: 1½ pounds or 24 ounces to each 1000 gallons of water in the morning; following this with 16 ounces to each 1000 gallons of water again at the beginning

of the afternoon run, where the washing operation has been fairly continuous since morning.

[fol. 627] The most convenient method of handling the Blue Stone is to place the Blue Stone crystals in a burlap sack, at or near the top of a barrel filled with a known quantity of water. If the solution is made up in the proportion of 1 pound or 2 pounds to each gallon of water, the required quantity for a tank of any capacity can be easily figured out. Never put the crystals directly into the soaking tank.

For Lemon Shippers

We have a record showing the quality of picking performed by the different lemon shippers and associations during the period covering approximately the last three and one-half months, developed through careful inspection by members of the field department. The period covered is somewhat longer than is usually the case in statements of this kind. Owing, however, to market and other conditions, the pickings were not as regular or frequent as is usually the case at this time of the year. The data presented, therefore, may cover several inspections of individual associations, especially in cases where the picking was carried on with much the usual regularity. The data indicate fairly accurately the quality of work performed during this period, and show that our shippers generally appreciated the fact that careful handling and sound fruit was fully as important, and even more so, than under ordinary conditions.

The picking inspections cover 45 houses; the average of defective picking is 4.2%, divided as follows:

Long Stems	2.9%
Clipper Cuts	.7
Green Pulled	.6
Total	4.2%

As a matter of comparison it is worthy of note that during the period, Dec. 29, 1919, to Jan. 24, 1920, there were 13 associations that had a record of less than 1% defective picking. During the period covered in this last statement, we have eight associations under 1%.

[fol. 628] For the same period a year ago, there were 32 associations out of 50 inspected which had defective picking of less than 3%. During the period last covered we have 19 out of 45 with defective picking less than 3%.

In other words—the statement of one year ago showed 26% of our lemon shippers with defective picking under 1% and 64% with defective picking less than 3%. The inspection data show for this last period 17.7% of our lemon shippers with defective picking less than 1%, and 42.2 with defective picking less than 3%.

While the picking as a whole is not as good as it was a year ago, it demonstrates that it has been possible, under the conditions that have existed, to secure almost perfect, picking where the work has been carefully and properly supervised.

[fol. 629] PLAINTIFFS' EXHIBIT No. 41

United States Department of Agriculture

Department Circular 293

Washington, D. C., October, 1923

Commercial Control of Citrus Stem-end Rot

John R. Winston, Pathologist; Harry R. Fulton, Pathologist, and John J. Bowman, Junior Pathologist, Office of Fruit-disease Investigations, Bureau of Plant Industry

Contents.

	Page
Cause of citrus stem-end rot	629
Pruning out deadwood	620
Spraying for stem-end rot control	632
Removal of stem "buttons"	633
Method of gassing	634
Holding at low temperatures	635
Quick marketing	635
Other procedures tested	635
General recommendations for control	636
Summary	638

Cause of Citrus Stem-end Rot

Stem-end rot of Florida oranges and grapefruit may be caused by either of two fungi, Phomopsis citri or Diplodia natalensis. The general appearance of the decay is the same in either case. At first there is a slight softening without discoloration over a small area immediately around the stem or button. This soft area enlarges rapidly and by the time it is an inch in diameter assumes a tan or light-brown color. When the main circular area of rot has included about one-third to one-half the surface of the fruit, fingerlike extensions sometimes spread downward in positions corresponding to the divisions between the segments of the pulp, and a small independent rotted area will regularly appear at the point end, the fungus having reached this region quickly by direct growth through the pith tissue of the core. The fruit may be completely rotted in three or four days from the first appearance of the softening if the temperature is favorable for rapid growth of the par- [fol. 630] ticular fungus in question.[1]

Both of these stem-end rot fungi flourish and form spores in dead citrus bark. Phomopsis usually develops most abundantly in recently dead bark of very small twigs and fruit stems; Diplodia occurs most frequently on larger twigs and limbs. During periods of warm, rainy weather the spore crops are produced and disseminated. While all the details have not been definitely determined, it seems

[1] Blue-mold rot.—Besides the two types of stem-end rot, Penicillium (blue mold, green mold, blister rot) is a common cause of decay. It can develop at lower temperatures than Phomopsis. It may enter at any point where the skin of the fruit is cut or bruised. Its development is very rapid, the primary infections showing as a rule within two or three days after entrance occurs. It requires different procedures for control from the stem-end rots. Briefly, the fruit must be kept free from bruises and scratches of all kinds and from long continuance of surface moisture—from rain or dew, from washing, or from condensation ("sweating")—and it should be held at low temperatures (40° to 45° F.).

most probable that first infection involves some portion of the stem button of the fruit some time during the growing season. Under certain unusual seasonal conditions, usually associated with drought and frequently near the time of maturity, stem-end rot may actively affect the fruit in the groves, causing considerable loss from dropping. Ordinarily little or no evidence of stem-end rot is seen until some time after the fruit is picked. The physiological changes following the separation of the fruit from the tree seem to be favorable for the active growth of both of these stem-end rot fungi and for their more or less rapid extension from the button tissues into the fruit proper. The holding temperature plays an important part in determining the rate of rot for a particular lot of fruit and also whether or not the Phomopsis or the Diplodia rot will prevail in cases of double infection. Diplodia develops best at about 85° F. and Phomopsis at about 75° F. Phomopsis can develop slowly in the 50's, but Diplodia is effectively retarded below 55° F.

Experiments for the control of both types of citrus stem-end rot conducted by the Office of Fruit-Disease Investigations of the Bureau of Plant Industry have followed many lines of attack, some of which have proved successful, some unpromising for commercial control, and some entirely ineffective. The following account includes those phases of the work that seem to offer practicable methods of control, with incidental reference to some of the other tested procedures. It is in the nature of a preliminary report for the immediate information of those concerned in the growing and marketing of citrus fruits liable to stem-end rot loss.

Pruning Out Deadwood

Theoretically the removal of places of spore production, if thoroughly done, ought to decrease the liability of the fruit to stem-end rot infection. Repeated observations and tests have shown that citrus fruits from comparatively young trees, in which there is relatively little deadwood, do not as a rule develop much stem-end rot in holding tests. Neither is fruit from such trees likely to be severely affected with melanose, a surface blemish also produced by Phomopsis citri.

Pruning experiments were conducted in 1921 and in 1922 on fairly well kept large seedling orange trees at Orlando, Fla., to determine the effect of cutting out deadwood on [fol. 631] stem-end rot. The work was done as carefully and thoroughly as could be expected on a commercial basis. In 1922 eight plats were pruned once each in every month from April to November, near the 10th of the month. Sample lots of 50 fruits were collected from each plat on three

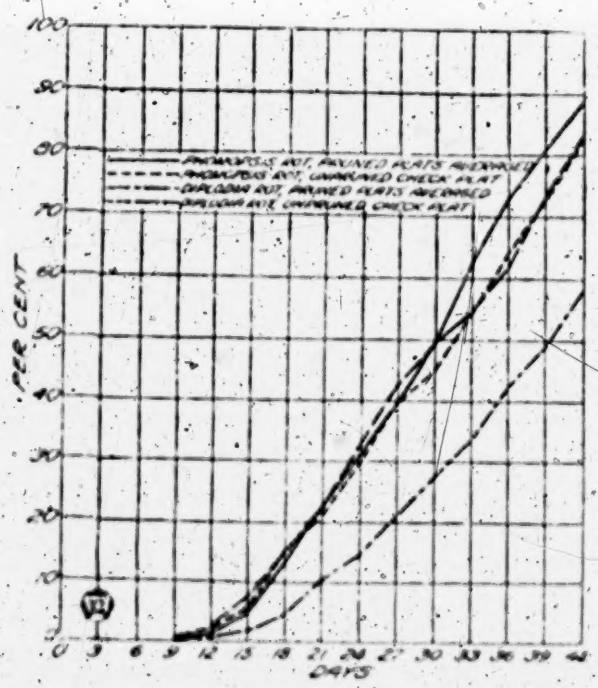


FIG. 1.—Development of Phomopsis rot and Diplodia rot in oranges from pruned plats and from unpruned check plats during the 42 days of the test. The numbers at the left indicate the cumulative percentages of rot, obtained as follows: For each period of 3 days the percentage of Phomopsis or of Diplodia rot is figured on the basis of the number of sound fruits in the test at the beginning of the 3-day period. These percentage figures are added successively to give the cumulative numbers shown. Such numbers represent the proportion of rot that would develop if the test lot were restored to 100 fruits after the removal of the rotten fruits at the beginning of each 3-day period.

dates—November 16 and 24 and December 22. These fruits were held for 36 days at 70° F. and then for 6 days at 80° F. —a range suitable for the development of blue mold as well as both stem-end rots. At 3-day intervals examination was made for rot, and all fruits showing stem-end rot were cultured to determine accurately whether it was of the Phomopsis or the Diplodia type. Figure 1 shows the average amounts of Diplodia rot and of Phomopsis rot for the eight pruned plats in comparison with the amounts for fruit from unpruned plats.

It is apparent that pruning has had no definite effect on the amount of Phomopsis rot, but there is a distinct diminution in Diplodia rot, the reduction being about 50 per cent during the first 27 days of the holding. However, it must be borne in mind that at ordinary marketing temperatures Phomopsis would have relatively a greater advantage over Diplodia than at the rather high temperature of 70° F. or higher used in the test. A reduction of 50 per cent in Diplodia rot with no control of Phomopsis rot probably would not make a very great difference in the total rots of Florida fruit in commercial practice. Perhaps the greater effectiveness of pruning against Diplodia rot is due to the fact that Diplodia is found for the most part on larger twigs and limbs that can be rather thoroughly removed. The innumerable small sprigs and fruit stems that regularly harbor Phomopsis can not be removed with thoroughness, and so this kind of infection is not checked. Pruning in every month from April to November reduced Diplodia, but the results were more marked in some months than in others. [fol. 632] Further tests must be made before it can be determined whether any particular time of year will prove to be consistently the best for such pruning work.

On the whole it would seem that pruning out deadwood alone can not be depended upon satisfactorily to control citrus stem-end rot, at least where Phomopsis prevails. When carefully done it may materially reduce Diplodia rot.

Spraying for Stem-end Rot Control

Spraying experiments followed by holding tests on the fruits during the past three years have indicated that ap-

plications of copper sprays that will control melanose on the young fruits will also in large measure reduce Phomopsis stem-end rot, but spraying later than about the first week in June is not effective for rot of this type. Up to the present time it does not seem possible to control Diplodia stem-end rot by an economically practicable spraying schedule. Figures 2 and 3 show results obtained on selected plats from the 1922 spraying experiments, which bear out the above general conclusions. The sprayed trees were old

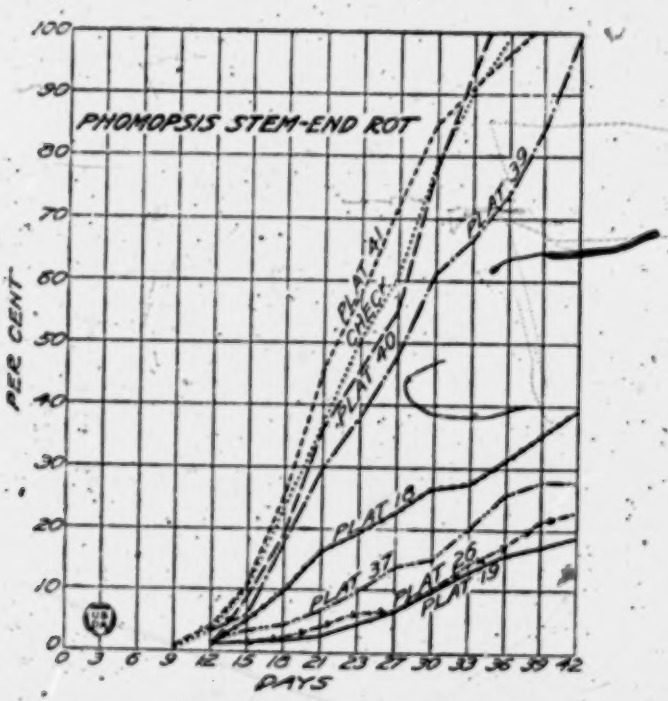


FIG. 2.—Development of Phomopsis rot in oranges from plats sprayed at various times with 3-3-50-1 Bordeaux-oil emulsion and from unsprayed check plats during the 42 days of the test. The numbers at the left indicate the cumulative percentages of rot, obtained as follows: For each period of 3 days the percentage of Phomopsis rot is figured on the basis of the number of sound fruits in the test at the beginning of the 3-day period. These percentage figures are added successively to give the cumulative numbers shown. Such numbers represent the proportion of rot that would develop if the test lot were restored to 100 fruits after the removal of the rotted fruits at the beginning of each 3-day period.

unpruned seedling orange trees with a large amount of deadwood. The spray-material was 3-3-50 Bordeaux mixture plus 1 per cent oil as emulsion. The plats shown in Figures 2 and 3 were sprayed on the following dates:

Plat 18, on April 10; plat 19, on April 10, May 1; plat 26, on April 12, May 10; plat 37, on April 12, May 11, June 10, July 10, August 10, September 10, October 10; plat 39, on June 10, July 10, August 10; plat 40, on July 10, August 10, September 10; plat 41, on June 10, July 10, August 10, September 10, October 10; plat 50, unsprayed check.

[fol. 633] It would seem that two applications, one early in April, the other early in May, give the best control of Phomopsis rot, although one application made on April 10 reduced this rot materially. Spraying seems to have some slight effect in reducing Diplodia stem-end rot, but not enough for its practical control.

Any spraying that will prove effective for melanose control[1] would be expected to have additional effect in controlling the Phomopsis type of stem-end rot.

Removal of Stem "Buttons"

Extensive experimental evidence indicates strongly that both Phomopsis and Diplodia first gain a foothold somewhere on the stem or button of the fruit and later grow through the stem cushion into the fruit proper. Removal of the stems before this extension into the fruit ought to prevent stem-end rot. Early tests in pulling the fruit from the trees showed that stem-end rot was very much reduced, but increase in blue-mold rot following the tearing of fruit tissues incident to the pulling offsets the saving from the stem-end rot. The gassing method for coloring citrus fruit, recently widely adopted in Florida as a result of investigations by the Office of Horticultural and Pomological Investigations of the Bureau of Plant Industry, often causes

---

[1] Winston, John R., and Bowman, John J. Commercial control of citrus melanose. U. S. Dept. Agr. Dept. Cir. 259, 8 p. 1923.

considerable shedding of buttons, which has been considered an objectionable feature. This suggested that gassing might be utilized for control of stem-end rot because of its loosening effect on the buttons. The results of extensive tests have been highly satisfactory, and it is believed that this process affords a comparatively simple and very effective means of controlling both types of stem-end rot and of

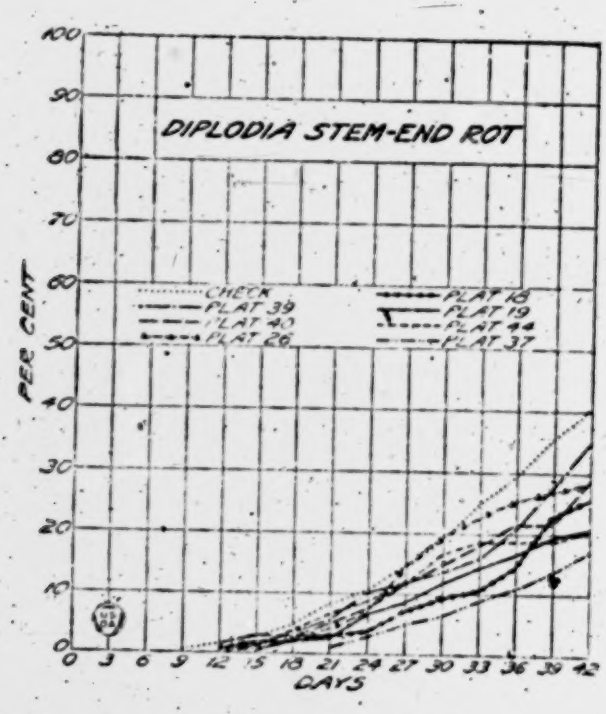


FIG. 3.—Development of Diplodia rot in oranges from plats sprayed at various times with 3-3-50-1 Bordeaux emulsion and from unsprayed check plats during the 42 days of the test. The numbers at the left indicate the cumulative percentages of rot, obtained as follows: For each period of 3 days the percentage of Diplodia rot is figured on the basis of the number of sound fruits in the test at the beginning of the 3-day period. These percentage figures are added successively to give the cumulative numbers shown. Such numbers represent the proportion of rot that would develop if the test lot were restored to 100 fruits after the removal of the rotted fruits at the beginning of each 3-day period.

greatly prolonging the life expectancy of fruit otherwise [fol. 634] liable to loss from stem-end decay. Figures 4, 5, and 6 show combined results from 19 tests with samples of 50 oranges each, conducted during the season of 1922-23. The fruit was taken from old trees with much deadwood and was more subject than the average to stem-end rots. The disbuttoning occurred at various times from 2 to 6 days after the fruit was picked. After treatment, the fruit was held for 36 days at 70° F. and for 6 more days at 80° F.,

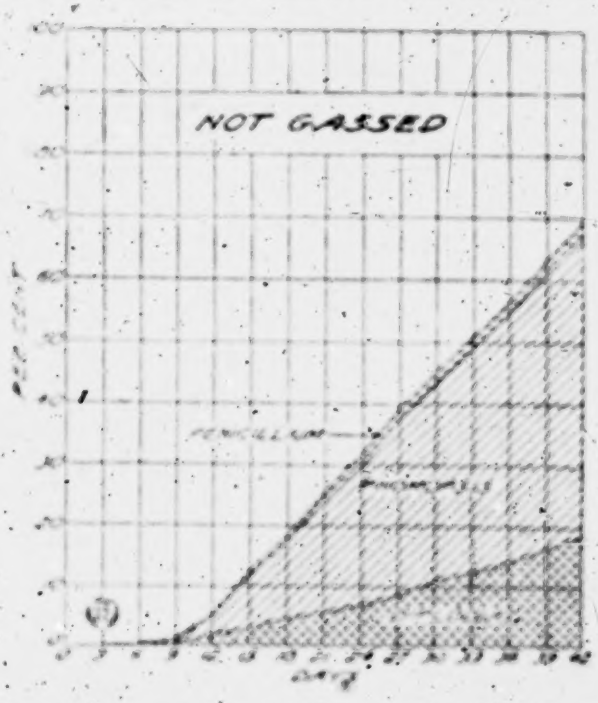


FIG. 4.—Proportions of various rots per 100 oranges originally in the test, not gassed, held for 42 days.

and the test was consequently very severe on the keeping quality. The tests show the effects on the various rots of gassing with stem removal as compared with gassing without stem removal and with untreated fruits. For the first 30 days of the holding tests stem-end rot is almost a negligible factor in the disbuttoned fruit. Under ordinary commercial conditions of lower temperatures the losses from stem-end rot in such treated fruit ought to be even less. Gassed fruit with buttons left in place kept hardly as well as untreated fruit.

Method of Gassing[1]

The most satisfactory method to follow in gassing[2] fruit to improve its color and at the same time to loosen the buttons is to subject the fruit for about 36 hours to gas from a gasoline engine exhaust or from a kerosene-oil stove with imperfect combustion, holding the coloring room at a temperature ranging from 80° to 85° F. with the humidity between 85 and 90 per cent. Sweating must be avoided to prevent blue-mold decay. Such a combination of factors causes the buttons to loosen and to be easily rubbed off by the brushes and polishers. The color develops and the buttons loosen simultaneously, hence there is no appreciable increase in the time that the fruit has to be subjected to the above conditions to obtain both results. Ordinarily, the cost of this process is not more than 1 cent per box.

[fol. 635] Holding at Low Temperatures

Figure 7 shows the development of the two kinds of stem-end rot when fruit is held at various temperatures ranging from 10° to 30° C. (50° to 86° F.). It will be noted that the amount of rot to be expected at any length of time from picking, or the time required to develop any given percentage of rot, depends on the holding temperature. Phomopsis in general ranges about 5 degrees C. (9 degrees F.) below Diplodia in its limits of activity. It is evident that loss from both types of stem-end rots may be

---

[1] General information about the construction and operation of coloring plants for Satsuma oranges is contained in United States Department of Agriculture Bulletin No. 1159, "Coloring Satsuma oranges in Alabama," by R. C. Wright. Detailed information on the gassing process for coloring citrus fruits, as adapted to Florida conditions, may be obtained from the Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

[2] Practically all of the technique involved in coloring and at the same time disbuttoning citrus fruits has been evolved by W. R. Barger, of the Office of Horticultural and Pomological Investigations, who has also rendered valuable assistance in conducting the tests mentioned above.

avoided for a reasonable marketing period if temperatures are kept low enough, probably not more than 45° F. for Phomopsis or 55° F. for Diplodia. The sooner the fruit is subjected to the low temperature and the quicker the interior of each fruit reaches such temperature the better the results. Pre-cooling seems to accomplish this end effectively.[1]

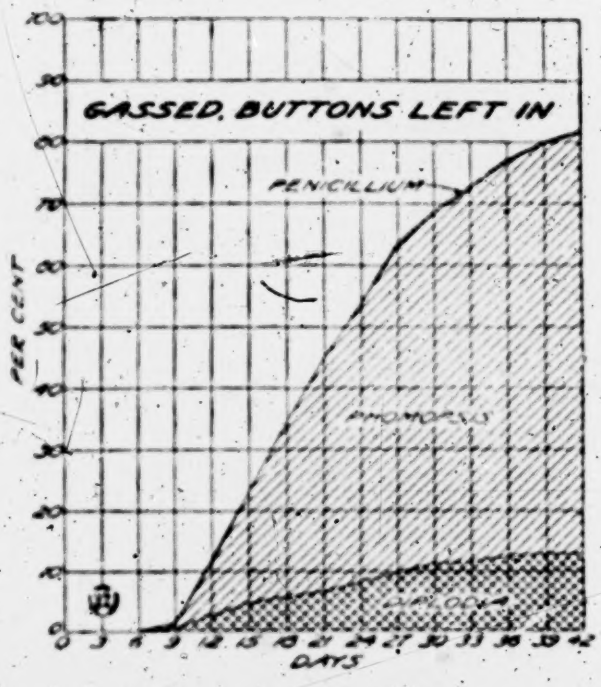


FIG. 5.—Proportions of various rots per 100 oranges originally in the test, gassed and buttons left in, held for 42 days

Quick Marketing

If holding temperatures are not kept low and if the potentially infected fruit is not otherwise protected from stem-end rot decay, it is of the utmost importance that it be consumed before the inevitable loss occurs. Delay in packing, too long hauls to distant markets, delays in transit, and

[1] Ramsey, H. J. Handling and shipping citrus fruits in the Gulf States. U. S. Dept. Agr., Farmers' Bul. 696, 28 p., 10 figs. 1915.

overstocking by dealers should be avoided in so far as may be possible. A peculiarity of both types of stem-end rot is that development of rot is long drawn out in any lot of fruit. A particular fruit may be entirely sound for many weeks and then over-night develop the first symptoms of stem-end rot. Such fruits are all right until rot sets in, but are worthless afterwards. Whatever can be done to shorten the average time from the tree to the consumer will lessen by so much the aggregate loss from stem-end rot.

Other Procedures Tested

It might be supposed that clippers would become more or less contaminated with Phomopsis or Diplodia spores and [fol. 636] the cut surfaces of the stems become infected through this agency. Tests have shown that when clippers are contaminated heavily in experimental trials stem-end rot is increased following their use, but numerous tests on clippers in active use in the ordinary way have failed to show any gain through disinfection of them between cuts.

On the hypothesis that the small portion of stem which is left when the fruit is clipped becomes infected after picking, particularly by Diplodia, it has been held[1] that shellacking the stem end will reduce this rot, this treatment being most effective when the fruit is pulled rather than clipped. The writers have tried this method repeatedly under Florida conditions with and without disinfection previous to shellacking. If the stems are left, the method does not control stem-end rot; if the stems are properly removed, the treatment is unnecessary.

Chemical disinfection in the soaking tank has not been effective.

General Recommendations for Control

It has been seen that the control of the two citrus stem-end rots is a complex proposition for which many people share the responsibility.

[1] Rogers, John M., and Earle, F. S. A simple and effective method of protecting citrus fruits against stem-end rot. In Phytopathology, v. 7, pp. 361-367, 1917.

The grower, as a matter of good grove practice, should keep his trees reasonably free from deadwood, but it is not practicable by this method alone to control stem-end rot. It has little or no effect on Phomopsis rot and reduces Diplodia about one-half. The cost of securing this reduction will be excessive in comparison with other control measures if the expense of deadwood removal is chargeable to this alone; where the pruning is necessary as a result of storm or cold injury the improvement in the keeping quality of the fruit may be reckoned as an additional gain. Spraying for melanose control (one or two applications of 3-3-

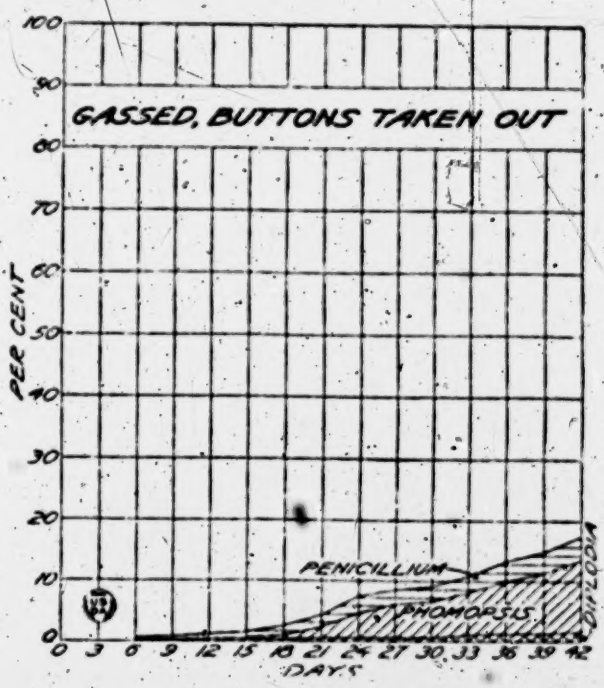


FIG. 6.—Proportions of various rots per 100 oranges originally in the test, gassed and buttons removed, held for 42 days

50-1 Bordeaux-oil emulsion between April 5 and May 5) will greatly prolong the keeping quality of the fruit through marked reduction of Phomopsis rot, but it will have only slight effect on Diplodia. In the light of our present knowledge it is doubtful whether the grower, in order to [fol. 637] control stem-end rot by spraying, would be justified in going beyond melanose-control requirements. He

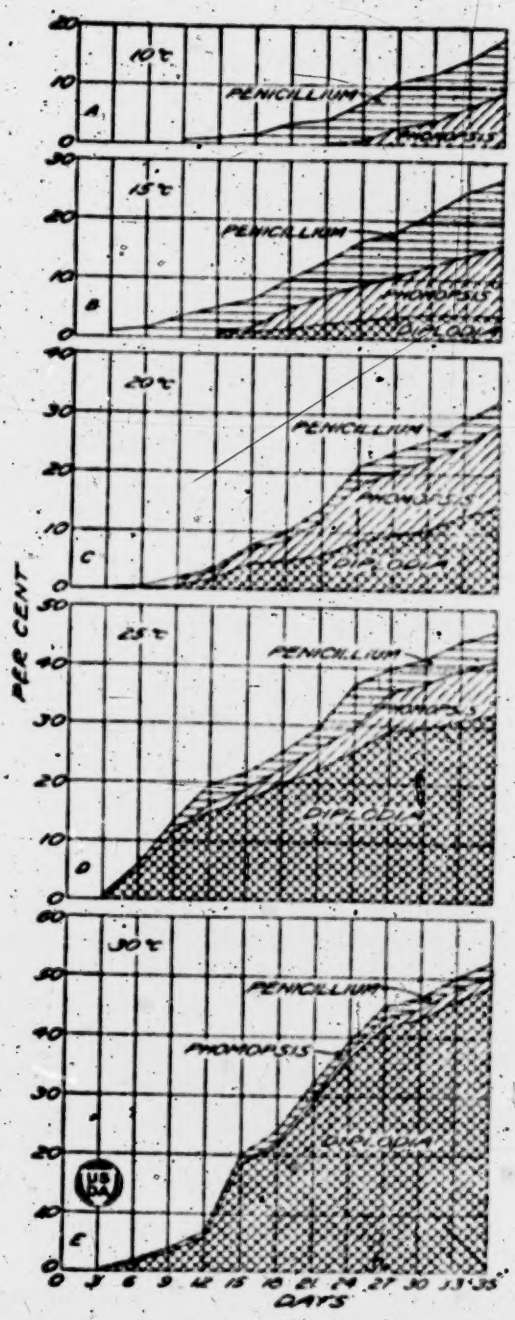


FIG. 7.—Proportions of various rots per 100 oranges originally in the test, held for a period of 36 days at the following temperatures: A, at 10° C. (50° F.); B, at 15° C. (59° F.); C, at 20° C. (68° F.); D, at 25° C. (77° F.); E, at 30° C. (86° F.)

may count such control as an added inducement to undertake spraying for melanose or as justification for two spray applications rather than one.

The packer will have the responsibility of deciding whether or not gassing for button removal shall be carried out on any particular lot of fruit. The evidence now indicates that fruit most subject to stem-end rot can be transformed into the very best keeping sort by disbuttoning, and that slightly infected fruit will thus be materially improved in keeping quality. If the fruit comes from young uninfected trees or has had effective melanose spraying, disbuttoning may be less necessary, particularly if the fruit is marketed quickly. The packer must see to it that the fruit is handled with the least possible delay and kept as cool as possible. He is responsible for precooling the fruit when advisable.

The carrier is responsible for transporting without unusual or unnecessary delay, and for proper attention to temperature and ventilation requirements in transit.

The dealer should try to speed up the prompt movement of citrus stock and especially should avoid keeping stock subject to stem-end rot on hand for long periods. He should hold it at temperatures low enough to effectively retard stem-end rot.

[fol. 638] The consumer also has certain responsibilities regarding stem-end rot. While for many reasons it may be desirable to purchase citrus fruit in quantity, as in original boxes, this involves risk when dealing with fruit subject to stem-end rot. Large retail purchases should be made only after reasonable assurance about their expected keeping quality, and the fruit should be held whenever possible at the temperature of a good refrigerator until used.

Summary

Briefly summarized, the following measures are recommended for control of stem-end rot in oranges and grapefruit: Prune the trees for removal of deadwood, in so far as good orchard practice requires. Spray the young fruit once or twice with 3-3-50 Bordeaux mixture plus 1 per cent oil as emulsion during April or certainly before May 5 (under ordinary Florida conditions), as may be required for good melanose control. If the fruit comes from old

trees with much deadwood, disbuttoning by gassing should be resorted to. Even if such trees have been pruned and the young fruit sprayed, disbuttoning will add to its keeping quality through more complete protection from stem-end rot. Keep the fruit at low temperatures, preferably between 40° and 45° F., and shorten as much as possible the time between picking and ultimate consumption.

[fol. 639] PLAINTIFFS' EXHIBIT No. 42

Western Australia Department of Agriculture

Leaflet No. 114

Blue Mould on Citrus Fruits

By W. M. Carne, Botanist and Plant Pathologist

Issued by Direction of the Hon. H. K. Maley, M. L. A., Minister for Agriculture

Perth: By Authority: Fred Wm. Simpson, Government Printer, 1923

The Occurrence of Blue Mould on Citrus Fruits

The occurrence of moulds (Penicillium spp.) is responsible for serious losses to citrus growers in the South-West, especially in exported citrus fruits and those held for some time in storage. Consignments to England this season (1923) have in many cases developed 25 or more rotten fruits per case, resulting in very low and unprofitable returns. The evidence at this end indicates that moulds have been the principal cause of wastage.

Infection.—The spores of the fungi are always to be found to some extent in every citrus orchard and packing shed. While carelessness may increase the number and the liability of damage, danger of infection is always present. Fortunately it is definitely known that perfectly sound fruits are seldom, if ever, attacked. It almost invariably happens that infection takes place on a bruise or some skin injury, often of the very slightest. Another necessary

factor to the development of moulds is moisture. Temperature is also important, but outside of cold store the tem- [fol. 640] peratures are usually high enough for the fungus, though the higher the temperatures the more rapid the development if other conditions are suitable.

The action of the fungus is to cause a rotting and breaking down of the fruit together with the release of moisture and the raising of the temperature. It is to these latter points that we owe the spread of the disease to adjoining fruits. Conditions are set up in otherwise sound fruits which render them liable to infection. The wrapping paper becomes sodden and is penetrated by the fungus and trouble spreads.

Mould is not very common on the trees, though common on fallen fruit. This is due to the fruit on the ground becoming bruised and being kept moist by contact with the soil. Where infection takes place on the tree, the probable causes are injuries due to thorns or rubbing and the collecting of water in the wounds or in the navels of navel oranges.

Mould appears more commonly in the packing shed or store where the temperatures are higher and the fruit often injured in picking and handling. This is especially the case when the weather is moist and the fruits picked in wet weather. In packed fruits, infection usually appears in the centre of the cases where temperatures are highest and ventilation to carry off moisture poorest.

The factors controlling infection are, therefore:

1. Presence of the fungi;
2. Injury to fruit;
3. Presence of moisture;
4. Sufficient temperature.

Taking these separately, the methods of control may be considered.

1. Presence of Fungi.—These are always present to some extent; but affected fruit should be removed from the packing house as soon as possible, preferably while in the white mould stage before the spores are formed (blue mould stage). They should be well buried as soon as possible, at least daily.

2. Injury to Fruit.—This is the important cause of [fol. 641] mould. Oranges probably require more careful

handling than any other fruit, especially when ripened in a wet climate, as the skin then becomes still more delicate. Injuries on the tree before picking usually develop a protective corky tissue which prevents infection, but this does not happen to injuries caused during picking and handling. It should be impressed on pickers that the most minute scratch from thorns, finger nails, clippers, etc., may result in mould. Bruises are a prolific cause of infection, and result from even a small fall though no injury be visible to the eye. In picking for export all fruit injured in any way by picking should be put aside for local sale, together with all fruit dropped in handling, or wind-falls. Export fruit should be confined to sound fruit picked from the tree. Fruit should be cut and not pulled, and placed, not dropped, into special fruit picking bags, which should be quietly and gently emptied into the boxes. The boxes should be handled gently and never jarred or dropped.

3. Presence of Moisture.—Citrus fruit should be picked dry and during dry weather. This is often impossible in the South-West. It should be thoroughly recognized that nowhere else are citrus fruits grown extensively under the conditions prevailing at Harvey and in the South-West generally. Elsewhere they are grown in tropical or semi-tropical regions with a summer rainfall coming after the fruit has been picked, or in regions of summer and winter rainfall, the latter rarely exceeding 10-15 inches, or under irrigation in places of little or no rainfall. The conditions in the South-West are unique with a rainfall of 30 or more inches during the ripening season. It follows that mould must be more carefully guarded against in the South-West than anywhere else. The conditions there, besides favouring fungi, also result in the skin of the fruit being more than usually delicate and liable to injury. It is therefore necessary to take the greatest care of the fruit, especially in seasons of abnormal rainfall.

As the fruit is likely to come into the packing shed wet [fol. 642] and in wet cases, it is necessary to dry it as soon as possible. This would be most conveniently done by means of fans in well ventilated rooms. Without fans and good ventilation the use of heat is worse than useless, as the warm humid conditions resulting are ideal for the growth

of fungi. In the absence of fans the best method would be to spread the fruit on benches with lath bottoms like packing tables, preferably in not more than two layers. The fruit should be allowed to remain on these tables up to three weeks if possible, though ten days to a fortnight will probably be sufficient. During this period of sweating or curing, the skin becomes tougher and more pliable owing to the loss of a certain amount of moisture. Sweating enables the fruit to be packed more readily and at the same time enables infected fruit to be detected and removed.

4. The Control of Temperature.—As the higher the temperature the better the mould thrives, the sweating room and packing shed should be open and well ventilated. To keep down the temperature of the fruit and at the same time to allow moisture from the fruit to be readily carried away, the cases used for packing should be as small and as narrow as practicable. The greater the width of the box the more difficult it is to secure ventilation.

Control.—Summing up, the methods of control may be stated as:—

1. Cut all fruit. Handle fruit like eggs. Discard all injured, bruised, or fallen.

2. Sweat on open benches in a well ventilated shed. Pack dry.

3. Wrap all fruit. Use the standard flat-bushel case (26 x 14¼ x 6 inches).

It is recognized that the adoption of the above recommendations means greater costs for labour in handling the crop. It is quite possible, however, that one-half the number [fol. 643] of cases shipped for a given amount of labour may be more profitable than double the number badly handled. The aim should be large returns, not large output. One case at 16s. to 18s. will more than cover expenses, where two cases at 8s. or 9s. are a dead loss. This has been illustrated in recent shipments, and there are indications that the highest prices have gone to the growers who took the most trouble and who used bushel rather than 1⅓ or 1½ bushel cases. Personal picking gives better results than paid labour, but it should be impressed on the picker that 25 cases

a day picked carefully is better than 40 picked carelessly, and so also with the packers and all who handle the fruit. Unless blue mould is controlled the prospects of Western Australia as a citrus exporting State are not at all promising.

[fol. 643a] PLAINTIFFS' EXHIBIT No. 43

American Fruits, Their Propagation, Cultivation, Harvesting and Distribution

By Samuel Fraser, M. S. in Agr., Fruitgrower, Nurseryman; Specialist in Transportation and Distribution of Fruits and Vegetables, Formerly Assistant Agronomist Cornell University.

Illustrated

New York: Orange Judd Publishing Company, Inc.

London: Kegan Paul, Trench, Trübner & Co., Ltd.

1924

[fol. 644] the eastern part of the United States. These spots do not extend very far into the pulp of the apple, consisting mainly of discolored skin, which is brown and corky;

Fig. 49. Sooty Blotch on apple—Professor Whetzel

or in the beginning it may appear as reddish spots which later turn brown. These spots do not appear to increase in size if the fruit is held in cold storage. The cause of the trouble is a fungus which usually is distributed during July or early August. The fungus enters the fruit from a stomata or breathing pore in which it may remain apparently harmless for nearly two months before it makes its presence manifest. The disease may develop rapidly in storage or when the fruit goes to market. The disease is

Fig. 50. The Fly Speck type of Sooty Blotch on the apple.—Professor Whetzel

usually controlled by spraying with a fungicide, once about the last of June and once later in July. Dusting may control equally well.

Soft rot or blue mold (Penicillium expansum). The name Soft Rot describes this common disease which is one of the most ruinous and destructive of our fungus troubles. Anyone who has fruit rotting from this disease will rec- [fol. 645] ognize it by the odor. The rotten area is very soft, watery, and may be yellowish-brown in color. It is a rot which primarily attacks ripe apples and does not usually affect green fruits. The bluish or greenish mold usually develops over the diseased area. The cause is a fungus, the spores of which are abundant in the air almost everywhere. If one falls into a wound, it germinates and

proceeds to develop, so that the disease is a secondary one. It gains its entrance through fingernail cuts, bruises, worm holes, scab and spray injury; in fact any injury may pave the way for it. The method of control is to prevent wounds or injury to the skin.

Pink rot (Cephalothecium roseum) is caused by a fungus which is present in the atmosphere and may develop in the wound of a ripe or nearly ripe apple, pear, quince, grape or plum; on apples, pink rot makes its attacks almost exclusively through scab spots. If apples be held at 32° F. the disease does not develop, but it may do so rapidly when brought out of storage. It is essential therefore that the skin of the fruit be kept intact and free from scab by spraying and that fruit receive careful handling.

Spongy dry rot (Volutella fructi) is seen in the Eastern United States and is caused by a fungus which attacks the fruit, causing the tissues to become spongy and dry. Orchards which are carefully sprayed are not apt to show much of this disease.

Hypochnus leaf blight (Hypochnus ochroleuca). This disease attacks the leaves of apples and the twigs, causing them to look as though attacked by fire blight. It occurs throughout the Southeastern United States. Its work may be distinguished from fire blight in that the leaves usually droop and are matted together and upon them the disease is apt to grow as small cinnamon brown bodies. Later the leaves fall. Spraying with Bordeaux mixture before the buds open and again before the blossoms open will usually control.

Jonathan spot. Such apples as Jonathan, Spitzenburg, Wealthy, Wolf River and some others are affected by a spot which develops markedly in storage and in transit—especially while fruit is in transit from the Western States. The spots may show on the fruits on the tree. At this time, they appear to be quite superficial. Their cause is not known, but they appear to be more prevalent following dry summers, and when

[fol. 646] two before being placed in storage and little perceptible harm result; while in the former case, two or three days out of storage may reduce the life of the fruits

from a month to six weeks. The grower must take all of these points into consideration. The same is true of peaches, plums, pears and much more of strawberries and raspberries.

The ideal system. When fruit is stored, the storage should be so near that the fruit may be cooled within two hours after it leaves the tree. Motor trucks should be going continuously from the orchard to the storage. It may be more important in hot weather to run the fruit into storage and cool it than attempt to pack it, if it is for long keeping. Of course, if it is going directly to the market, or if the storage period is to be short a rehandling under such conditions is undesirable. The delay in placing in storage may be compensated by the reduction in cost of handling.

Necessity for care in handling. Fruit roughly handled in picking or packing, causing it to be bruised or the skin punctured by finger-nails, or pinched in the hands of the picker, has a much shorter storage life than fruit not so injured. A break in the skin allows the entrance of the blue mold fungus, which seldom attacks a fruit with a sound skin. This blue mold formerly was a most serious trouble with citrus fruits. Greater care in handling has greatly reduced the trouble.

Storage diseases. In certain seasons, bitter rot causes considerable trouble to apples in storage. This disease develops rapidly, especially when the apples are somewhat overgrown; or when the season has been wet just prior to harvest. Stippen or Baldwin spot develops more rapidly in seasons when the water supply is unequal or the trees fail to function properly. In other cases scab paves the way for the entrance of the pink-rot, which may cause considerable wastage of the fruit in barrels. In peaches and plums, brown rot may work havoc while the fruits are in storage. Some of the cankers which attack fruit trees affect the fruit and may lead to a rapid breakdown of the tissues in storage. Hence, the man who gives the orchard good care and keeps these diseases under control may be adding considerably to the life of the fruits.

Scald. Certain varieties of apples, such as York Imperial, Wagener, Rhode Island Greening, Rome Beauty and

Stayman often show a marked tendency to turn brownish-skinned after being——

[fol. 647] by pruning to maintain satisfactory growth and sprayings of bordeaux mixture, although such treatment is not always profitable.

Damping-off (Rhizoctonia sp.). Young seedling trees in the nursery are often affected by the damping-off fungus. The trouble begins usually just below the surface of the ground. The tissues break down and the tree falls over. The only way to prevent is to keep all the conditions for growth favorable. Spraying with bordeaux mixture may aid.

Black Pit, Citrus Blast (Pseudomonas citriputeale) is sometimes seen on lemons which are over-ripe. Dark brown to black depressions one-eighth to one-half inch in diameter appear on the rind, due to a bacterium obtaining entrance through some wound. Prune the trees to form a compact head to protect against wind injury.

Twig Blight, Cottony Mold or White Rot (Sclerotinia libertiana). The fungus causing this disease may develop in the soil during the rainy weather, also on the green manure crops, particularly vetch. The disease is most common in wet years, appearing on twigs as white mold; on the fruit it may pass from one lemon to another while they are in the wash water or if lemons are allowed to stand after harvest. The fungus develops as a white mold and appears over the surface of the lemon. If the disease is prevalent vetch should not be used as a cover crop.

Brown Rot (Pythiacystis citrophthora). This is more commonly seen on lemons than on oranges. It causes a brown, rather dry decay of the rind. The fungus lives in the soil and is passed from one lemon to another after harvest, or while they are being washed. The fungus lives on the bark, causing exudation of gum. Such affected areas must be thoroughly cleaned out and the wound treated with bordeaux paste. The fungus is destroyed by placing it in a copper sulphate solution of 1 to 1½ pounds to 1,000 gallons of water, accordingly the lemons are washed in this to check it. If the wash water used is alkaline it may take more. To be effective the treatment must be made within eight hours after infection. Washing the fruit or holding it in hot water at a temperature of 115 to 120° F. for two

minutes is more effective. Spraying the ground under the trees and the trunk of the tree with bordeaux mixture every fall is worth while.

Blue Mold (Penicillium italicum) and Green Mold (P. dig- [fol. 648] itatum). These are the common causes of decay in citrus fruits. They usually make their entrance on the surface of the fruit where bruised or otherwise injured. Formerly much fruit was lost from these diseases but with greater care in the growing and handling of the fruit these diseases have been materially reduced.

Gray Mold (Botrytis cinerea). This is not serious; it usually develops on weak fruits and is seen on the rind of lemons. It may develop on fruit in cold storage when it is caused by gummosis on the tree.

Black Rot (Alternaria citri) occurs in wet weather and is more commonly seen on the Navel orange as a dry black rot at the navel end. Usually it is not serious. The Red Rot frequently occurs on lemons as a dry, red, sunken area. Its cause is unknown.

Puffing. In certain seasons the surface of the skins is rough and the skin itself spongy, the whole orange being soft. This is usually due to unfavorable moisture conditions.

Splitting. Oranges sometimes crack and split before becoming mature; this is more often seen in dry and hot weather and may be due to lack of proper development of the rind.

Galls. Some of the gall-like growths which occur on the branches are believed to be due to the same bacterium which causes crown gall on peach and other plants. Galls do not appear to be serious.

Citrus Canker (Pseudomonas citri) is one of the most serious diseases of citrus fruits and should it become generally distributed it would be a great handicap to the citrus industry. The disease is seen on the leaves, twigs and fruit of the grapefruit as small spots which finally coalesce. The area is light brown in color and is coated with dead cells. The dead area may project on the surface on both sides of the leaf. On twigs a year old the injury appears as a canker confined to the outer tissue of the bark. The organism may remain alive and virulent for twenty-six months. The infected trees should be destroyed where they stand by burning them. An oil or gasoline spray is applied

to aid combustion or a torch is used. After the tree is completely destroyed, the soil where the infected tree stood is disinfected with formaldehyde and water.

Melanose (Phomopsis citri) is a fungus disease which attacks the fruit. It lives on the young stems of all kinds of citrus —.

[fol. 649] PLAINTIFFS' EXHIBIT No. 44

Preliminary Results with the Borax Treatment of Citrus Fruits for the Prevention of Blue-Mold Rot [1]

By Harry R. Fulton, Pathologist, and John J. Bowman, Junior Pathologist, Office of Fruit Disease Investigations, Bureau of Plant Industry, United States Department of Agriculture.

Recent studies by the senior author on the effect of ultraviolet light in disinfecting the surface of citrus fruits, details of which will be published in the near future, have indicated that more than 99 per cent of blue-mold spores may be killed very quickly by light of short wave lengths, and at comparatively low cost, but that blue-mold rot is not proportionately checked. The two weak points in the ultraviolet treatment seem to be (1) the difficulty in killing the last small percentage of Penicillium spores, and (2) the lack of any later protection against stray spores that remain unkilled or may reach the fruit. Being thus strongly impressed with the desirability of using some agent that would have a continuing effect, the writers have undertaken the testing of a large number of mild chemical reagents with a view to finding inhibiting rather than killing substances. The stronger disinfectants would be objectionable, because their poisonous character would not permit residues to be left and because many of them would actually injure the surface of the fruit if not immediately washed off.

---

[1] Received for publication July 3, 1924—issued Nov. 1, 1924. This paper has been referred to the Bureau of Chemistry, United States Department of Agriculture, for consideration regarding the use of borax.

Journal of Agricultural Research, Washington, D. C., Vol. XXVIII, No. 9, May 31, 1924, Key No. G-490.

The general procedure has been to select chemicals for preliminary tests largely on the basis of cheapness and availability. Spores of Penicillium were treated with relatively strong solutions of these chemicals for periods of 1 to 24 hours, and were then plated to determine the killing effect. Parallel tests were made for inhibition. Any reagent that seemed at all promising was then applied to a few citrus fruits to determine whether it would injure the skin. If it seemed safe to use, an actual test was made to determine its protective action on severely wounded and inoculated fruit held under conditions of temperature and moisture favorable for blue mold development. Usually some one of the stronger fungicides was included in each test as a basis for comparison.

Holding tests have been made thus far with fruit treated with solutions of the following chemicals: Sodium sulphate, sodium bisulphite, sodium borate, sodium fluoride, sodium perborate, sodium chloride, potassium permanganate, potassium borate, copper borate, bichloride of mercury, boric acid, salicylic acid, benzoic acid. Among these sodium borate, or borax, has seemed to give best protection against blue mold rot.

The results of one holding test, made March 14, 1924, which included borax along with certain other materials will serve as an illustration and is shown in Figure 1. California navel oranges purchased in the Washington, D. C., market were used. The fruit was soaked for 10 minutes in inoculum carrying about 500,000 per cc. of mixed Penicillium digitatum and P. italicum spores. The fruits were dried, then atomized with the chemical solution (the control with water); dried again; punctured 100 times with pins to a depth of about half way through the peel. They were wrapped in waxed paper, packed in a tight barrel with wet [fol. 630] newspaper between each two layers of fruit; and were kept at room temperature of about 72° F. Examination for rot was made every three days. The result shows some benefit from all of the chemicals; 1:5000 bichloride of mercury, 5 per cent boric acid, and 5 per cent sodium bisulphite had approximately the same effect; and 5 per cent sodium borate (borax) was distinctly more effective, particularly during the first 24 days of the test. In Figure 2

are shown the average results of 15 tests on oranges of 5 per cent borax treatment, as compared with no treatment, and 5 tests on lemons. These tests were made at various

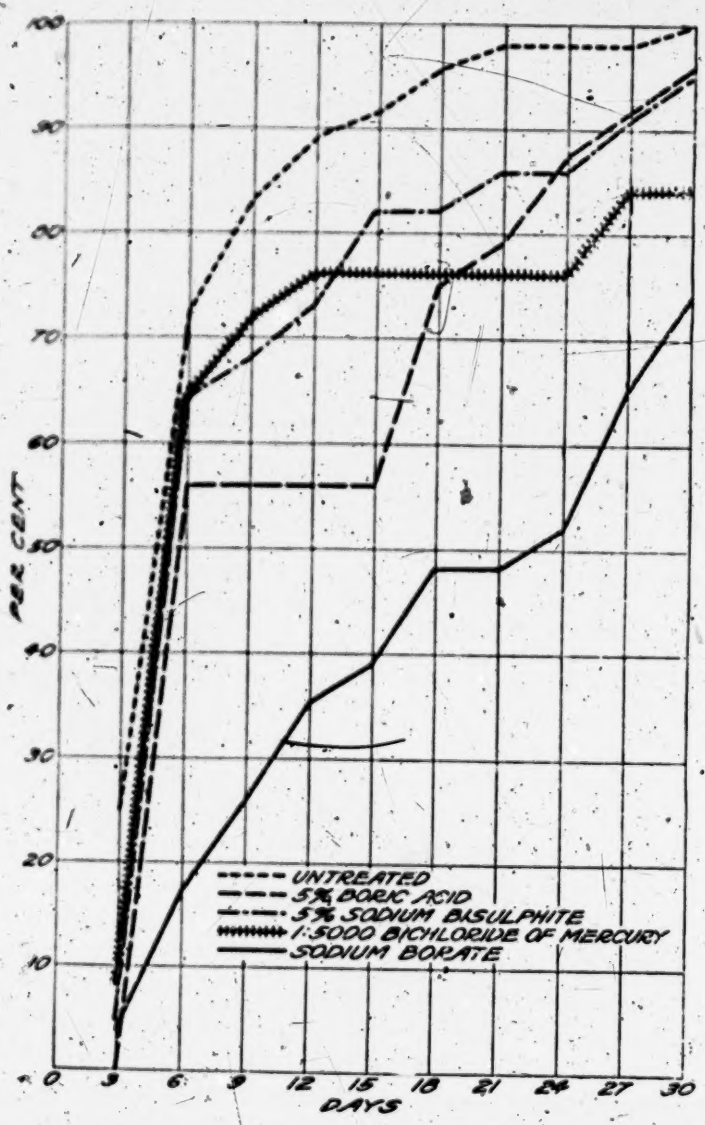


Fig. 1.—Percentages of blue-mold rot developing in oranges treated with various chemicals and those untreated during 30 days.

times. In all cases the fruit was punctured at 100 points, was inoculated with a suspension of blue-mold spores, and was packed between wet paper. The strength of the inocu-

lum was varied in some of the tests, as was the sequence of [fol. 651] puncturing, inoculating, and treating with borax. The method of applying the 5 per cent borax solution was either by dipping the fruit momentarily in the solution, or by soaking for 1 minute or for 10 minutes, or by atomizing over the fruit, or by applying with a brush; all of these methods proved effective. The averages are based on 491 treated and

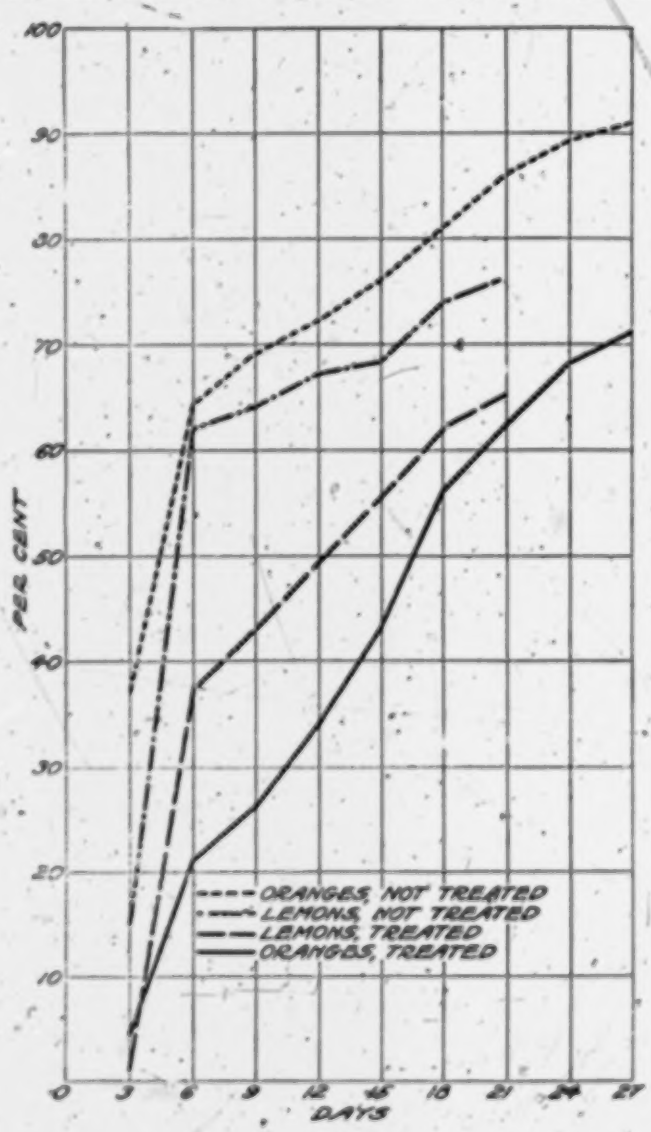


Fig. 2.—Percentages of blue-mold rot developing in oranges and in lemons treated with 5 per cent borax solution and untreated during 27 and 21 days.

an equal number of untreated fruit for the oranges, and on 270 fruits for the lemons. They show the effectiveness of the

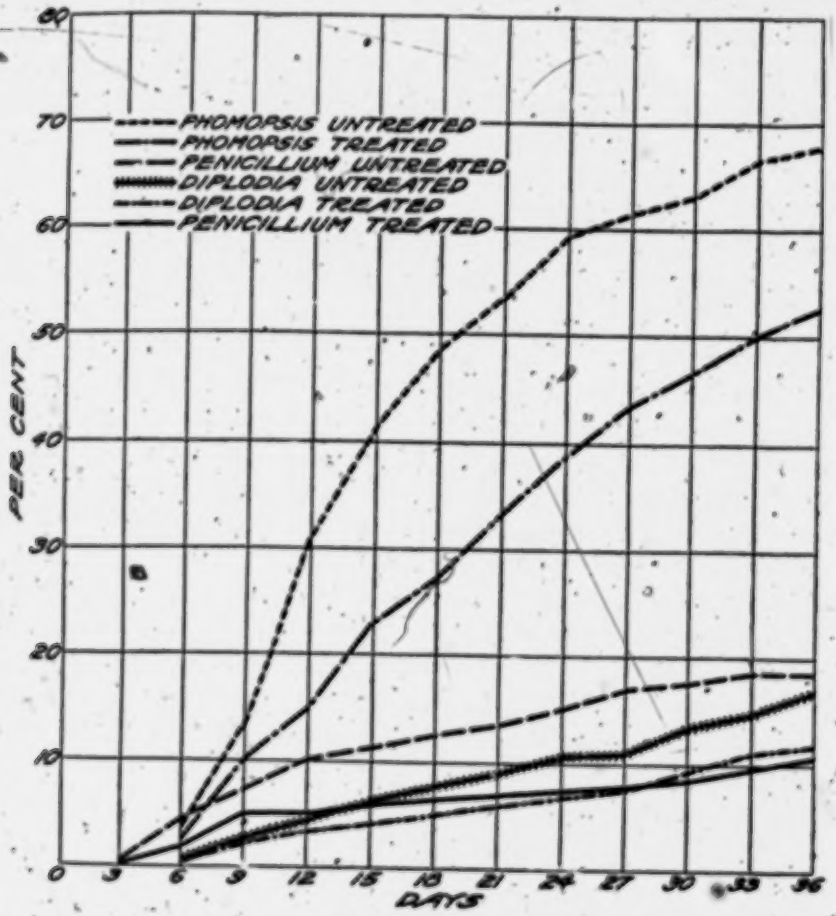


Fig. 3.—Development of Phomopsis stem-end rot, Diplodia stem-end rot, and blue mold rot (Penicillium) in oranges treated with 5 per cent borax solution and untreated during 36 days. The numbers at the left indicate the cumulative percentages of rot obtained as follows: For each period of three days the percentage of Phomopsis or of Diplodia or of blue mold rot is figured on the basis of the number of sound fruits in the test at the beginning of the three-day period. These percentage figures are added successively to give the cumulative numbers shown. Such numbers represent the proportion of rot that would develop if the test lot were restored to 100 fruits of like kind after removal of the rotten fruits at the beginning of each three-day period.

treatment under conditions of infection far more severe than would occur in even the worst commercial practice. The treatment with 5 per cent borax solution resulted under these exceedingly severe conditions in a distinct reduction in blue-mold rot, but did not give what would be considered satisfactory control. The treatment seemed to be more effective on oranges than on lemons.

[fol. 652] In certain other tests the fruit was not only punctured, but was severely bruised by dropping several times from a table to the floor, and several slices resembling very severe clipper cuts were cut from the outside of the peel. In such cases soaking one minute 5 per cent borax solution had a very satisfactory protective effect, but the mere brushing on of the solution was less effective.

A preliminary test to determine the value of the borax treatment under commercial conditions was made in Florida with oranges. In one series of tests samples of 100 fruit were taken from the packing houses; each sample was divided into two lots, one lot was dipped momentarily through 5 per cent borax solution and the control lot through water; the fruit was allowed to dry, and was held for several weeks at approximately 74° F. in a rather moist atmosphere. These conditions of temperature and moisture are more favorable for rot than usual commercial conditions, but were considered desirable in order to induce enough rot for a definite showing. In Figure 3 the averages are given for 11 sample lots of 50 oranges each, representative of Florida [fol. 653] oranges in late April, including Valencias in their prime and seedling oranges that were dead ripe. There is a distinct reduction in all three rots, Phomopsis and Diplodia stem-end rots showing decided reduction as well as blue-mold rot. This reduction in stem-end rots was an entirely unexpected outcome of the experiment. One possibility is that the borax solution may penetrate and disinfect the calyx edges or other portions of the button in which these two stem-end rot fungi are established, and from which they later extend their growth into the stored fruit.

Two commercial shipments of boxes of oranges and of grapefruit were made, one during April and one in May, 1924, from points in Florida in regular fruit cars under refrigeration to Seattle, Wash., and by ordinary express to Washington, D. C. Not enough blue-mold rot developed in

either the treated or the untreated fruit for definite showing, even during a holding period of several weeks duration after arrival. The boraxed fruit in these shipments again showed a distinct reduction of stem-end rot when compared with the controls. Further tests will be made to determine the effect on blue-mold rot of the borax treatment in commercial shipments.

The question arose as to whether increasing the strength of the borax solution would give better control. At ordinary air temperature water saturation occurs at about 6 per cent or 7 per cent of borax, but solubility increases rapidly with rise in temperature. At 85° F. it is approximately 7 per cent; at 113°, approximately 14 per cent; and at 122°, approximately 18.5 per cent. In California lemons and oranges are usually washed for several minutes in water between 115° and 120° for control of brown rot without bad effect. In the warm-water tests the writers have used 10 per cent commercial borax in water maintained at 122°, on plump but not turgid fruit that had been off the trees at least 10 days when purchased from the market. Seven tests, two with oranges and five with lemons, are averaged in figure 4. The percentages of rot are based on [fol. 654] 275 fruit originally given each treatment. There is some difference in favor of the 10 per cent as compared with the 5 per cent borax dipping treatment. It is possible that soaking tests of several minutes in the warm solution would show an increased effectiveness. The question requires further testing under commercial conditions of handling the fruit.

In packing houses having soaking-tank equipment a convenient place for applying the borax treatment would be in this tank. Usually the fruit passes from the soaking tank to scrubbing brushes over which streams of water play. These would wash off most or all of the borax. In the absence of a soaking tank, or for the purpose of leaving as much as possible to dry on the fruit surface, the borax solution might be played over the scrubbing brushes in small streams from perforated pipes leading from overhead tanks, or some atomizing device might be used just before the fruit enters the drier. Where polishing brushes are used after the fruit has dried, much of the borax coating would be removed. Tests were made to determine whether the removal of the borax coating, either by washing the

freshly treated fruit or by brushing those on which the borax had dried, would materially lessen the protective effect. The fruit was heavily inoculated and was packed

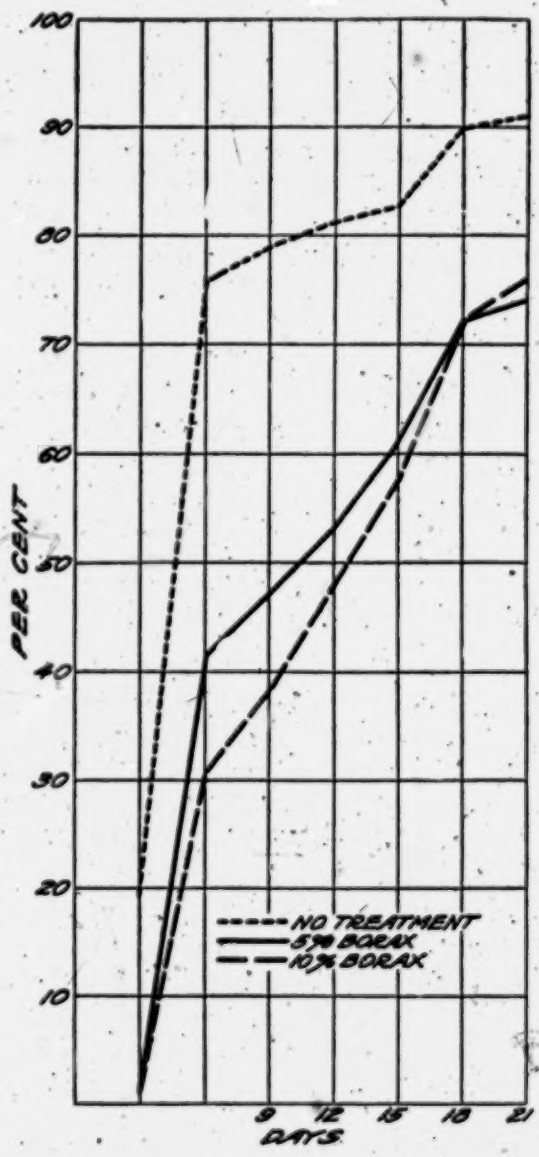


Fig. 4.—Percentages of blue-mold rot developing in citrus fruit treated with 5 per cent and with 10 per cent borax solution and untreated during 21 days.

away between layers of moist paper at room temperature. Figure 5 shows the average results of seven separate tests,

five with lemons, and two with oranges, totaling 340 fruits. The strength of the borax solution was 5 per cent for five of the tests and 10 per cent for two.

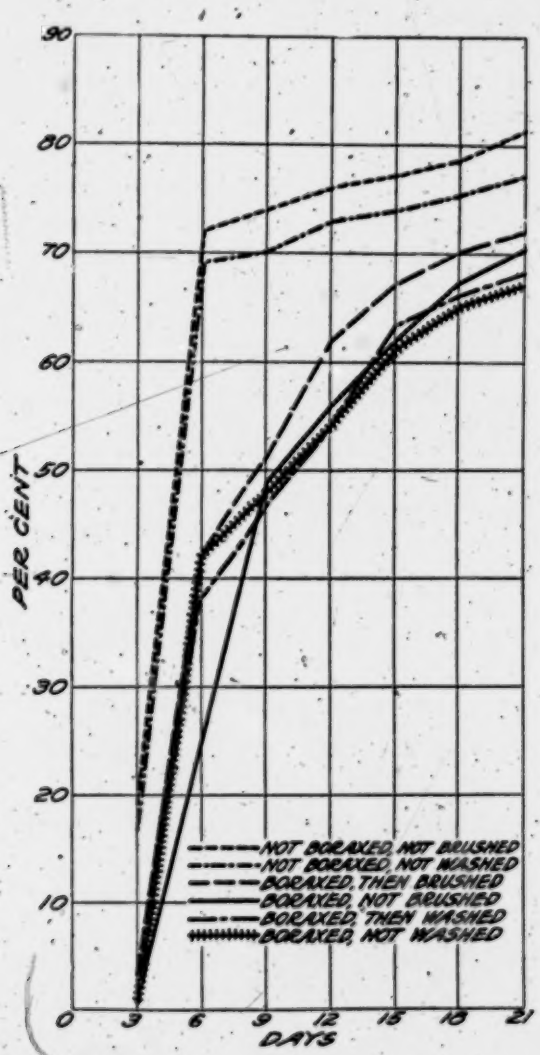


Fig. 5.—Percentages of blue-mold rot developing in citrus fruit treated with borax solution (two tests), treated with borax solution and later washed, treated with borax solution and later brushed, and untreated (two tests) during 21 days.

These results indicate that removal of the coating of borax really makes little difference. This is at variance

with the working hypothesis on the basis of which this work was undertaken. It may be that borax penetrates to some extent the tissues, especially at wounds, and thus has a residual effect even though the surface crystals are not present in quantity. However, one would naturally suppose that a surface coating of small crystals of an antiseptic substance that would readily dissolve in any moisture that would allow spore germination would give added effectiveness in pre- [fol. 655] venting such germination or subsequent invasion by the fungus mycelium. After the brushing the deposit of borax crystals remained, or was even increased in depressions, but was removed from the high places.

Practical packing-house tests will be required to determine the most effective and economical way of applying the borax treatment. From these preliminary laboratory tests it seems that the treatment would be about equally effective in any one of the several methods of application discussed.

Tests were made on the effectiveness of borax treatments at various intervals after artificial inoculation. The best results were obtained when the treatments followed immediately. With the lapse of two and one-half hours the treated fruit was no better than the untreated control. On the other hand, the tests with "commercially sound" fruit taken from packing houses, frequently one or two days after picking, indicate a material reduction in blue-mold rot and in stem-end rot, as is shown in figure 3. It is important to avoid delay in treating the fruit, and the borax treatment must not be relied upon to make up for careless handling. All the tests with severely wounded fruit indicate that the borax treatment will by no means prevent all of the rot. In general the laboratory tests had the advantage over carelessly handled commercial fruit of receiving the treatment promptly after wounding and had the disadvantage of being subjected to exceedingly severe wounding and holding conditions. The borax treatment should be regarded as a supplement to and not as a substitute for careful handling. It gives promise of having a place in protecting the fruit against a considerable proportion of the blue-mold rot that is likely to occur even with very careful handling, especially that incident during and after the packing process.

Borax has the advantage of being cheap and readily obtainable. It does not actively corrode metal and is not a

poison. It is an article of common household use. The coating, even when freshly made with 10 per cent solution, is not very conspicuous on oranges and lemons; on grapefruit it shows at first somewhat more prominently as a grayish coating. After the fruit has been wrapped and packed and held for a week or more, one must look very closely to detect any difference in appearance between the treated and untreated fruit. It does not seem probable that the borax coating, even if all is left on the fruit, will detract materially from its appearance or affect its marketability.

As is well known, regulations of the United States Department of Agriculture, made under the pure foods act, prohibit the use of borax or certain other preservatives in food products and restrict their use on the surface of such products. In the case of citrus fruits the application of borax is made to the outside of the peel, a portion of the fruit that is not regarded as edible and that is discarded in the ordinary consumption of the fruit. If the fruit is washed before using, the adhering borax is readily removed. In commercial establishments for extracting juice and for manufacture of citrus by-products the general practice is to wash the fruit before using. In the making of citrus drinks the fruit is doubtless used sometimes without washing and the peel put in the drink. In this case there is considerable dilution with liquid. Our tests show that an orange of medium size, on an average, will remove 1 cc. of 5 per cent borax solution when dipped. Perhaps half of this drains off. On this basis a single orange might carry 0.025 gram (0.4 grain) dried borax on its surface. The therapeutic dose is given as 0.750 gram (12 grains), and is the equivalent of what might be carried on about 30 oranges.

Chemical analyses are being made by the Office of Soil Fertility Investigations of this bureau to determine the amount of borax present on and in the peel and in the edible pulp portion of oranges and of lemons that had been held [fol. 656] 15 days after treatment with borax solution of 5 per cent and of 10 per cent strength. Preliminary results indicate that the amounts present are even much smaller than those indicated and that the borax does not penetrate to the edible portion of the fruit.

No injury to the fruit through the use of borax solution has been observed. Most of the tests were made with fruit

obtained on the market some time after picking, but a number of tests on grapefruit and on oranges were made with freshly picked fruit. The effect on very turgid fruit has not been fully tested.

Summary

Preliminary tests have shown that commercial borax (sodium borate) solution in strength of 5 per cent or 10 per cent applied to the surface of oranges or lemons and allowed to dry greatly reduces blue-mold rot under experimental conditions that are unusually favorable for rot development.

Oranges and grapefruit handled in a commercial way, when treated with the borax solution, showed a marked reduction of both Phomopsis and Diplodia types of stem-rot rot, as well as of blue-mold rot.

The borax treatment gives promise of being commercially valuable in conjunction with careful handling of the fruit, in reducing losses from blue-mold rot.

[fols. 657 & 658] PLAINTIFFS' EXHIBIT No. 45

November 1, 1924. The Florida Grower

now come into such general use. Others began experiments very shortly after we started, and you all know of the wild-fire spread of pre-coloring since that time.

With the characteristics of the Parson Brown oranges you are all familiar. The Davis Seedless grapefruit is not so well known and I may state that this is a variety originally propogated at the Little River test grove of the U. S. Bureau of Plant Industry. In the Redland section of Dade County it is the variety of grapefruit now grown almost exclusively, and during the past few years has also been planted in some other sections of the state. It has several good qualities which have no bearing upon the subject under discussion, but has two which very decidedly do. The fruit is of mild flavor, without being insipid, and will pass the 7 to 1 acid ratio test from two to four weeks earlier than Duncan, Marsh, Pernambuco or Common Florida growing, in the same grove. Yet practically any of these other varieties will show the so-called "color of maturity" long before the Davis Seedless. It is the Parson Brown of the grape-

fruit family with the difference that the Davis does not lose flavor after it takes on full color, and is really an excellent fruit for spring shipment.

I cannot speak for the others who took part in these earlier tests, but Dr. Hawkins and I certainly went into the matter with our eyes open. We knew that if some adaptation of the gas process proved as successful in the pre-coloring of oranges and grapefruit as it had with Satsumas, we were unleashing a pack of troubles for the Florida citrus grower. But we thought, and personally I still think, that we were justified in making the tests and giving full publicity to the results. We knew that in all human probability the process would be misused, but for that there seemed to be a perfectly practicable remedy.

To successfully market citrus fruit, there are two essential qualities which the fruit must have: It must have appearance to bring about the first sale to the consumer. And one requisite of appearance is color, for we have taught the consumer, through bitter experience, to shun green fruit. In the second place, it must be of such edible quality that the verdict of the palate will confirm the judgment of the eye and bring about repeat sales. If Parson Brown oranges, Davis Seedless Grapefruit, or any other varieties of citrus attain an edible condition before they become fully colored, and we can impart that color without impairing other qualities, are we not justified in so doing, when this means that these early ripening varieties may then be moved out of the way of the slower-maturing fruit, which makes up the great bulk of the crop which must be handled? Dr. Hawkins and I thought so in 1921 and I very positively think so now.

As to the abuses which have come with pre-coloring, your remedy is just the same as it is for the shipment of all other immature citrus fruit. Get behind a State law with teeth in it that will reinforce the present Federal regulations and let that law provide for a sufficient corps of high-class, well paid inspectors to see that its own restrictions are fully enforced. You are entitled to it. Why don't you go to Tallahassee and get it?

Controlling Blue-mold Rot of Citrus Fruits with Borax Solution

By H. R. Fulton and J. R. Winston, U. S. Bureau of Plant Industry, Orlando, Florida

In an effort to find an effective, non-injurious and cheap disinfectant solution for the prevention of blue mold rot of citrus fruits, the office of Fruit Disease Investigations of the United States Bureau of Plant Industry has conducted extensive tests which included some fifty or more chemicals. Out of these, borax has given the best results, and gives promise of being a most effective agent in protecting citrus fruit from rot.

Early tests, in which the fruit was merely dipped in a five percent solution of borax (made at the rate of one pound of commercial powdered borax in two and one-half gallons of water) and immediately dried showed a reduction from ten to five percent in blue mold rot on the 12th day from the packing house. This was the average of eleven tests which included dead ripe seedling oranges as well as Valencias in their prime—all being of low grade to make the tests severe. A surprising and gratifying development was the reduction at the same time of stem end rot from 35 to 18 percent.

Soaking the fruit in the cold five percent solution for ten minutes did not greatly increase the effectiveness of the treatment, and washing or brushing off the solution did not greatly lessen its effectiveness.

Since a five percent solution of borax is near the saturation point, and since it seemed desirable to test the value of a stronger solution, the water was heated to 120° F. and the strength of borax was doubled, making it 10 percent. It was known from the experience of California lemon and orange packing houses using the hot water treatment for brown rot control that this temperature would not be injurious, except possibly in the case of very turgid fruit treated when fresh from the trees and cold, and that in such cases holding the fruit for a day would put it in proper condition for safe treatment.

Simply dipping the fruit in the hot 10 percent solution did not show a decided advantage over dipping in the cold five percent solution. But soaking the fruit for five minutes

in a hot solution, either 5 or 10 percent strength, increased the effectiveness to the point of preventing about 90 percent of the blue mold rot. It has not yet been demonstrated that soaking in the hot solution is much more than 50 percent effective against stem end rot. Hot water alone was not highly effective. The relatively slight added benefit from using the hot 10 percent solution as compared with the five percent hot solution does not seem from present evidence to justify the doubled cost for materials. It is important to use the five percent solution at about 120° F. and soak the fruit long enough for this degree of heat to penetrate the peel, which is about five minutes.

This hot five percent borax treatment for five minutes has proved effective on purposely wounded fruits when the soaking tank contained an excessively large number of blue mold spores; it was also effective against incipient rot in fruit 24 to 36 hours after the fruit had been purposely inoculated. Even when the rot spots had become plainly visible, one-quarter inch or more in diameter, the hot treatment had a decided checking effect but did not stop all of the rot.

The evidence indicates that the hot soaking treatment is more effective than the cold dipping or sprinkling treatment largely because of the added heat effect on the actively growing fungus in recently infected wounds, before, however, the fungus has penetrated too deep to be effectively reached by the borax or the heat. While the treatment will control incipient blue mold rot if given soon enough, it must not be relied upon to make up for careless handling or for unwarranted delays in the handling of the fruit.

The findings from the experimental tests would appear to warrant commercial shipping tests. Details of applying must be worked out in each packing house to meet the conditions existing there. A treatment with five percent solution for five minutes at 120° F. is desirable from the standpoint of effectiveness. Exhausts from gasoline or crude oil engines can be carried through a special soaking tank by means of pipes; hot water coil pipes can be placed in the heater for the drier; or a simple steam feed cooker can be used as a means of heating the water. To keep the borax solution as clean as possible and so save renewal costs, the

fruit should be run first through a soaking tank or over wide spaced rollers to get rid of trash and loose dirt. If kept reasonably clean, the borax solution ought to last several days without changing, probably as long as a week.

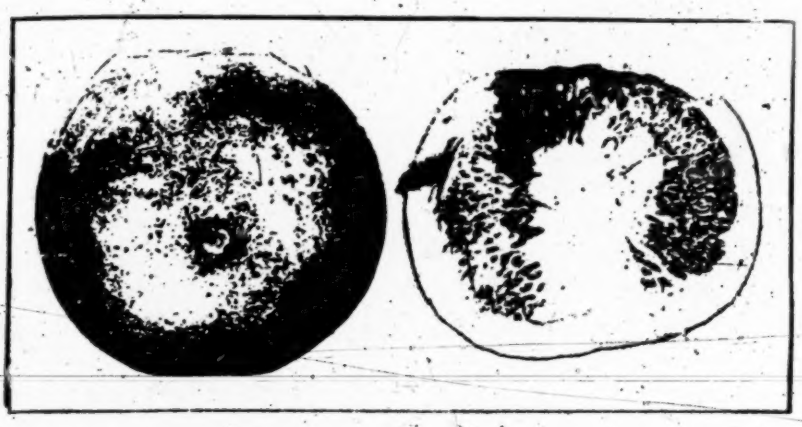
The borax tank should be long and broad and comparatively shallow so that the fruit will move slowly through it, and volume of solution be kept down. An agitating device may be needed to keep an even temperature; and automatic thermostatic control would insure against too high temperature; although such devices are not generally found necessary in the California hot water tanks.

A return drain to conserve the borax solution, and perhaps a pump to circulate the solution through the sprinkling pipes over the scrubbing brushes, would be desirable in a complete installation. The fruit will carry out a certain amount of solution, and the level in the tank must be maintained by additions of water and borax in proper proportions. It is probable that hard waters would combine with part of the borax, thus requiring a correspondingly higher percentage. Waste must be taken care of, so as to avoid the possibility of the borax getting into soil where crops are to be grown. It is well known that relatively small amounts of borax in the soil injuriously affect citrus trees and other growing plants. The bacterial action in septic tanks may also be adversely affected.

If it is desired to try a simple temporary installation for cold borax solution, with the expectation of securing about 50 percent control of blue mold and stem end rots, a perforated pipe could be arranged to thoroughly sprinkle the fruit before it goes into the drier. Such a system could be operated by gravity from an elevated tank, or a pump could be used and the waste collected and kept circulating.

If arrangements are made for getting the most good out of a tankful of borax, by keeping the solution free of trash so that it can be used several days, the cost per car for the treatment will be low, probably between one and two dollars. If the greater part of each barrel of borax has to be thrown away, and only a small part really finds effective use on the fruit, the cost for material may easily be trebled. A carefully planned installation will soon pay for itself in saving on borax.

The writers would be glad to advise with packing house managers regarding the details of any tests they may wish to make.



[fol. 659] PLAINTIFFS' EXHIBIT No. 46

IN THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF DELAWARE

In Equity. No. 593

BROGDEX COMPANY, Plaintiff,

vs.

AMERICAN FRUIT GROWERS, INCORPORATED, Defendant

STIPULATION

It is hereby stipulated and agreed:

1. That photostatic copies of the following letters, copies of which are attached hereto, may be used at the trial of the above entitled cause, in place of the originals:

(a) Letter of October 17, 1924 from Florida Citrus Exchange to all Sub-Exchanges and Association Managers.

(b) Letter of November 17, 1924 from same Exchange to same persons.

(c) Letter of January 13, 1925 from same Exchange to same persons.

(d) Letter of October 28, 1924 (2 pages) from same Exchange to same persons.

(e) Letter of December 23, 1924 from same Exchange to same persons.

(f) Letter of December 30, 1924 Bulletin No. 20 from Orange County Citrus Sub-Exchange.

2. That the above enumerated letters were written, and sent by and to the persons named, on or about the dates of the letters.

3. That the letters of H. R. Fulton, Pathologist, of October 14th and 25th, 1924, and December 10th and 26th, 1924, quoted in some of the above enumerated letters, were written by H. R. Fulton of the Bureau of Plant Industry of the [fol. 660] U. S. Department of Agriculture, and were sent by him on or about the dates which those letters bear, to the persons to whom those letters are addressed.

4. That the defendant reserves all right, however, to object to the admissibility of said letters above mentioned in paragraph 1, upon all other grounds.

((Signed) Wm. G. Mahaffy, Solicitor for Plaintiff. (Signed) Charles Mears, (Signed) R. F. Stewart, of Counsel. (Signed) A. C. Gray, Solicitor for Defendant. (Signed) W. B. Morton, of Counsel.

November 23, 1926.

Florida Citrus Exchange Bulletin

B. M. No. 10

Tampa, Florida, October 17, 1924.

To all subexchange and Association managers.

GENTLEMEN: We invite your attention to the following, which is a copy of a letter received from Mr. H. R. Fulton, of the Bureau of Plant Industry, U. S. Department of Agriculture:

Orlando, Fla., Oct. 14, 1924.

Florida Citrus Exchange, Tampa, Florida.

GENTLEMEN: The experiments that we have been conducting for the past eight months show that blue mold rot

[fol. 661] can be reduced about one-half by dipping citrus fruit in a 5% borax solution at ordinary temperatures. If the temperature of the borax bath is raised to between 115 degrees and 120 degrees F. (which temperature oranges and grapefruit stand without injury), and the soaking is prolonged to five minutes, 90% of the blue mold rot is prevented under conditions extremely favorable for its development.

The borax treatment also reduces stem end rot 50%, and possibly more.

A publication giving the detailed results has been delayed in press. This advance announcement is made so that Florida shippers may consider the question of trying out the treatment early in the shipping season. Please let us know about any points on which you may wish further information. The matter is still in the experimental stage but is at a point where commercial trial seems justified.

It is requested that the matter be kept from the press for the present, until publication can be made of the evidence on which the conclusions are based.

Yours truly, (Signed) H. R. Fulton, Pathologist.

Mr. Fulton's report on the results of the above experiments is highly appreciated and pass it on to you, for your information.

Yours very truly, Florida Citrus Exchange. C. E. Stewart, Jr., Business Manager.

[fol. 662] Florida Citrus Exchange Bulletin

B. M. No. 24

Tampa, Florida, November 17, 1924.

To all subexchange and Association managers.

GENTLEMEN:

Re Borax Treatment

Mr. J. W. Andrews submits the following:

"The Winter Haven Citrus Growers Association has recently installed equipment for testing, on a commercial scale the use of borax as a decay preventive. The so-called cold

5% method is being used at present and special inspections will be made at markets to determine the efficiency of the system.

The Winter Garden Citrus Growers Association has arranged to install equipment for testing the efficiency of the heated 5% solution and it is expected that shipments from this point will move within the next few days.

The Exchange will endeavor to secure careful checks on tests from both houses and the same will be reported when received. In both places the U. S. Department of Agriculture is planning to compile data similar to their work recently done in California.

It is believed that within the next thirty days there will be interesting developments that will be helpful to Associations in determining the best methods to employ, should they wish to adopt a system of protection. As soon as possible details of these tests will be compiled and issued from this office in bulletin form.

Yours very truly, Florida Citrus Exchange. C. E. Stewart, Jr., Business Manager.
CES-ER.

[fol. 663] Florida Citrus Exchange Bulletin

B. M. No. 41

Tampa, Florida, January 13, 1925.

To all subexchange and Association managers.

GENTLEMEN:

Re Borax Treatment

Considerable interest is being taken in results of shipments of fruit which have been treated with borax. The following cars have been treated wtih the hot borax treatment and shipped from the Winter Garden house, and those of you who would like to follow these through can do so by referring to the bulletins and checking up these numbers:

FCE	FCE
5134 Pittsburg	5360 N. Y. Clyde
5621 N. Y. Clyde	5361 Pittsburg
5262 Philadelphia	5458 Potomac Yards
5266 N. Y.	5522 N. Y. Clyde
5271 N. Y.	5523 Potomac Yards
5272 Pittsburg	

The following cars were shipped to Jacksonville and by boat to New York. The report on arrival on these is as follows:

FCE
5261 Boat New York—sound
5266 " " " —oranges practically sound, tangerines 5%
5271 " " " —Arrived perfectly sound

Yours very truly, Florida Citrus Exchange. C. E. Stewart, Jr., Business Manager.

CES-JPM.

[fol. 664] Florida Citrus Exchange Bulletin

B. M. No. 20

Tampa, Florida, October 28, 1924.

To all subexchange and association managers.

GENTLEMEN: Referring to our Bulletin No. 10 with regard to the use of borax solution for the prevention of blue mold rot, we invite your further attention to the following letters from Mr. H. R. Fulton, Pathologist, outlining proper methods of preparing and using the solution:

Box 1058, Orlando, Florida, October 25, 1924.

Mr. O. M. Felix, Asst. Bus. Mgr., Florida Citrus Exchange, Tampa, Florida.

DEAR MR. FELIX: I have your inquiry of October 24th about the details of the borax treatment of citrus fruit for prevention of blue mold rot.

Five per cent solution is made by dissolving ordinary powdered borax at the rate of one pound of borax to 2½

gallons of water, or 40 pounds of borax to 100 gallons of water. For satisfactory results the solution should not be used weaker than 5%.

If the hot (120 degrees F.) borax treatment is used, the borax strength can be carried to 10%, but the relatively slight added benefit, in our trials, has not seemed to justify the doubled cost of materials.

If trash and dirt are kept out of a borax soaking tank, we believe the solution can be used for a week, or even longer.

It is desirable to leave a good coating of the borax solution on the fruit as it goes into the drier. If the cold solu- [fol. 665] tion (giving about 50% control of both blue mold rot and stem end rot) is to be used, a simple gravity sprinkling device for the fruit as it leaves the scrubbing brushes would be an economical arrangement.

The hot 5% borax treatment for about five minutes at 120 degrees F. gives about 90% control of blue mold rot and at least 50% control of stem end rot. Where proper installation can be made, this is the preferable treatment. Exhaust from gasoline engines or from steam boilers can be carried through the tank in flues or pipes; or a simple steam food cooker may be used for the purpose. To keep the borax solution as clean as possible and so save on renewal cost, the fruit should be run through a soaking tank, or over wide-spaced rollers, to get rid of trash and loose dirt. The hot borax tank should be broad and shallow so that the fruit can move slowly through it.

Borax ought to cost about six cents a pound wholesale. Exact quotations can be obtained from any large dealer in fertilizers or spray materials. Large supplies would probably have to be shipped in from New York or elsewhere.

Yours very truly, (Signed) H. R. Fulton, Pathologist.

Box 1058, Orlando, Florida, October 25, 1924.

Mr. O. M. Felix, Asst. Bus. Mgr., Florida Citrus Exchange, Tampa, Florida.

DEAR MR. FELIX: Since writing you this morning, I have remembered that a caution should be given about the disposal of used borax solution. Relatively small amounts in the soil injure citrus trees and other growing plants.

[fol. 666] While several of the Florida concerns are getting quotations on borax and preparing to handle orders promptly, it may be that some managers will want to buy direct from the manufacturers. Among those listed in trade directories the following have high ratings:

Charles Cooper & Co., 194 Worth St., New York City.
Pacific Coast Borax Co., 100 William St., New York City.
Chas. Pfizer & Co., 81 Maiden Lane, New York City.
Roessler & Hasslacher Chem. Co., 709 6th Ave., New York City.

Yours truly, (Signed) H. R. Fulton, Pathologist.

The advice and information furnished by Mr. Fulton, in this connection, is of great value to us and we trust each Sub-Exchange and Association will take advantage of it.

Yours very truly, Florida Citrus Exchange. C. E. Stewart, Jr., Business Manager.

CES-ER.

Florida Citrus Exchange Bulletin

B. M. No. 35

Tampa, Florida, December 23, 1924.

To all subexchange and association managers.

GENTLEMEN:

Re Bulk Cars—Borax; Loading

We have sent out two cars of bulk oranges which were treated with borax. These arrived absolutely sound. Other [fol. 667] cars of bulk are beginning to show considerable decay and causing our dealers to become discouraged.

Mr. Andrews is out of the state at present checking up the shipment of bulk fruit that has been treated by borax but he will return in a day or two and can arrange for the installation for either the hot or cold borax treatment in your packing house. The cost of this, as the writer understands it, is from fifty to seventy-five dollars for the cold borax installation, per unit.

Mr. Andrews telegraphed this morning and states that it would be better not to wash the fruit unless it is properly dried and no bulk car should be loaded unless they are properly loaded and the soft fruit taken out.

Important: He found on examination of some bulk cars that tangerines were often put in the bottom and oranges put on top of them, in bulk. Such a condition is almost unbelievable and it seems unnecessary to tell any of you not to load cars in this manner but it seems from his experience that it is necessary to do so.

If some care is taken with the loading of these cars of bulk fruit, and only good, eatable fruit is put in the car, we are in a way to establish a very profitable business, but if the cars are not properly loaded and all manner of culls are thrown into the car you are going to kill this bulk of this business before we ever get it started.

A car of bulk fruit is not a dumping ground and the fruit should be carefully culled and properly loaded.

Yours very truly, Florida Citrus Exchange. C. E. Stewart, Jr., Business Manager.

CES-JPM.

[fol. 668] Bulletin No. 20

Orlando, Florida, Dec. 30, 1924.

To all association managers.

GENTLEMEN: The following is a copy of a letter received from Mr. H. R. Fulton, Pathologist, giving the results obtained on shipments of borax treated oranges. We are sending this along to you for your information:

"Washington, Dec. 26, 1924.

Orange County Citrus Sub-Exchange, Orlando, Florida.

GENTLEMEN: Commercial test shipments of borax treated oranges from Florida to New York during this month show that under ventilation the 5% cold borax treatment prevented 70% of the blue mold rot and 59% of the stem end rot; while 5% hot borax treatment (soaked at 120 degrees F. for 5 minutes) prevented 92% of the blue mold rot and 76% of the stem end rot. These figures are the averages from three lots of fruit and are in line with our holding tests previously reported to you.

Yours truly, (Signed) H. R. Fulton, Pathologist."

We are also giving a copy of Mr. Fulton's letter of Dec. 10th referred to by him in his letter of Dec. 26th.

"Washington, December 10, 1924.

Mr. L. A. Hakes, Mgr. Orange County Citrus Sub-Exchange, Orlando, Florida.

DEAR SIR: You may be interested in the following report on an express shipment of oranges to Washington, D. C. Part of the fruit had been treated with cold 5% borax spray after washing; and was then dried, polished, graded and sized in the usual way; and part was left untreated for [fol. 669] comparison. The fruit was third grade, and it was held after arrival in Washington at temperatures ranging between 70 degrees and 76 degrees F. so the test conditions were more severe than in ordinary commercial shipments.

Packed and shipped November 28, 1924; arrived Washington, D. C., December 1, 1924.

Percentages indicate total of blue mold and stem end rots up to the day indicated.

The figures in parenthesis indicate the blue mold rot alone.

Days from packing	3rd	6th	9th	12th
Borax treated	0	0	7% (2%)	14% (2%)
Untreated	0	2%	27% (5%)	60% (8%)

This cold borax shower bath cost less than 1/5 cent per box. This installation is very simple.

The hot 5% borax treatment (at 120 deg. F. for 5 minutes) is more effective and at the same time more expensive than the cold treatment.

Yours very truly, (Signed) H. R. Fulton, Pathologist."

Yours very truly, Orange County Citrus Sub-Exchange. L. A. Hakes, Manager.

LAH-A.

[fol. 670] PLAINTIFF'S EXHIBIT No. 47

The Citrus Industry

The Only Publication in the World Devoted Exclusively to Citrus Fruits

Issued Monthly

Representative of Every Interest—Representing no Special Interest

Vol. 6. Tampa, Fla., February, 1925. No. 2

Preliminary Report of the Effect of Hot Water, Hot and Cold Borax Solution on Scale Insects

By W. W. Yothers, Associate Entomologist, Orlando, Florida

It has been found by other investigators that blue mold of citrus is practically prevented by soaking the fruit in a 5% solution of borax heated in 120° F. for five minutes. From the standpoint of the citrus industry, this is a most remarkable and marvelous accomplishment.

It was thought advisable to determine the effect of this solution on the more common scale insects infesting the fruit. The following table gives the results of the count:

Tests Made October 30, 1924—Orlando, Florida

Red Scale

Treatment	Adult Females		%	Remarks
	Dead	Alive	Dead	
Cold Borax	58	54	51.7	Several Crawlers
Hot Borax	105	6	94.6	2 with Crawlers
Hot Water	71	6	92.2	
Untreated	Not enough insects			

Purple Scale

Treatment	Adult Females		%	Remarks (with normal eggs)
	Dead	Alive	Dead	
Cold Borax	84	32	72.3	16
Hot Borax	100	1	99.	14*
Hot Water	101	3	97.11	12†
Untreated	80	33	70.9	2

*2 Crawlers Alive. †4 Crawlers Alive.

[fol. 671] An examination of the above results certainly shows that the 5% borax solution did not kill the scale insects unless it was heated to 120° F. It also shows that the water without borax, heated 120° F. killed the same percentage of scale insects. In several instances the purple scale females had been killed but several eggs appeared normal. While, no doubt, some of these will not hatch, there may be a few which will. The heat seemed to be more effective on the red scale eggs than it did on the purple scale eggs and, vice-versa, it was more effective on the purple scale females than it was perhaps on the females of the red scale. In no instance was a perfect mortality obtained.

[fols. 671a & 672] PLAINTIFF'S EXHIBIT No. 48

March, 1925. The California Citrograph

Treating Oranges with Borax Solution for Control of Blue and Green Mold

By William R. Barger, Bureau of Plant Industry, U. S. Dept. of Agriculture

Borax or some other compounds of boron have been used commercially as antiseptics and preservatives for many years. Practical experience has shown that it is second only to common salt as a preservative. It is used extensively in the preparation of meat for export and in the manufacture of paste and glue, to prevent the growth of molds, especially blue mold. Many citrus packing houses in California use borax or boarx soap in the process of washing the fruit and when the solution is left to dry on the fruit, less decay seems to develop.

These observations have been confirmed experimentally and considerable work has been done in testing out the value of borax or boron derivatives as preventatives of fungus decay. R. E. Smith tested out boric acid and copper sulphate. In 1906 Smith tested boric acid among other things

---

* The writer wishes to thank the California Fruit Growers Exchange and especially its field department for hearty cooperation in the experimental work.

in the control of Brown rot of lemons. In 1907 Shear, Miles and Hawkins tested borax in combination with copper sulphate for the control of black rot in grapes. Fulton and Bowman have tested the effects of sodium borate, sodium perborate, potassium borate, copper borate and boric acid on the control of blue mold. Their results are presented in a recent article in the *Journal of Agricultural Research:* In experiments carried on in our laboratories last year, solutions of potassium, alum, salt, zinc chloride, boric acid, and borax—were used for the control of blue and green mold. The best results were obtained with the last mentioned chemicals, though partial control was obtained with some of the others.

In this work special attention was given to developing the best method of applying borax to the fruit and the work was confined largely to determining the concentration of borax, time of application and temperature of solution which gave the best results most economically.

Experiments with ripe navel and valencia oranges injured in the laboratory, treated with borax solution and then inoculated with blue and green mold spores proved conclusively that fruit can be protected from the growth of mold. The fruit in these experiments was held seven weeks after treatment. Over 8,000 fruits were used and the result of these tests are now in press.

An orange packing house with a capacity of three cars of fruit per day was equipped with machinery for the borax treatment to all the fruit by adding a soaking tank with accessory parts designed during the investigation. With this installation, further experiments under commercial conditions were carried on and car shipments as well as holding tests of injured and inoculated fruit were made.

Late valencia oranges were used in these experiments. These were injured by clipping away a piece of the skin and a mixture of blue and green mold spores was then rubbed on the injury. The following day the fruit was soaked in borax solution and run over the regular packing house machinery. After being wrapped and packed, the fruit was held at constant temperature at a high humidity and inspected each week for six weeks. The decay in the fruit that was not treated with borax shows that optimum conditions for mold growth were present. Over 13,000 injured and inoculated fruit were used in these experiments,

covering different strengths of borax, various periods of soaking and different temperatures of solution. The percentage of decay in comparable lots of fruit not treated and treated with borax solution is given in the accompanying graphs.

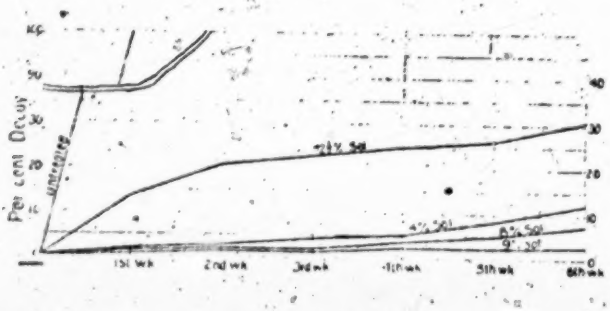


Fig. 1. Percentage of decay due to blue and green mold in untreated fruit and fruit soaked for six minutes at 110 degrees in 2½%, 4%, 8%, and 9% borax solution.

Figure 1 shows the percentage of decay due to blue and green mold in untreated fruit and fruit soaked for six minutes at 110 degrees in 2½%, 4%, 8% and 9% borax solution. The unsoaked fruit was soaked in water. From 70% to 98% reduction in decay due to the treatment with borax is shown and the decrease in decay follows the increase in the percentage of borax in the solution.

Figure 2 gives the percentage of decay due to blue and green mold in untreated fruit and fruit treated with 4% borax solution applied at 69 degrees and 110 degrees and the periods of four and six minutes.

Fig. 2. Percentage of decay due to blue and green mold in untreated fruit and fruit soaked in 4% borax solution at 69 and 110 degrees F., and for periods of four and six minutes.

Much less decay is shown in the lots of fruit soaked in 110 degrees solution for six minutes as compared with the shorter periods of time and lower temperature.

In addition to these experiments, experimental shipments were made with the commercial run of fruit. Fruit from the same grove was taken, part of which was washed in water only and part was soaked in borax solution. This fruit was treated for about five minutes with concentrations of borax ranging from 2½% to 6%. On arrival at the market these shipments showed an average of five times as much decay in the untreated as was found in the treated fruit, and approximately the same proportional difference in decay was obtained after ten and 21 days in lots held at the market. The appearance of the fruit was not injured by the treatment.

Besides these shipments with treated and untreated fruit in each car, thirty carloads of fruit were treated with borax solution and shipped. Only one of these cars of fruit showed sufficient decay on arrival at the market to be considered commercially. The decay in this car was 3%. Just prior to this time, 31 solid cars of untreated fruit were shipped and eight arrived with commercial decay, including two cars with 3%, one car with 4% and 5%, three cars with 5%, one car with 6% and one car with 10%

After considering the experimental data and the data obtained from the commercial shipments, there seems to be no question but that blue or green mold decay can be controlled by soaking oranges in 7% borax solution at 110 degrees for five minutes.

Overhead Sprinkling Systems Viewed by Interested Growers

Citrus Growers in districts of Orange and Los Angeles and some from San Diego and Venture counties where the overhead sprinkling system of irrigation is adaptable, recently combined in a field day trip, under direction of Harold E. Wahlberg, Orange county farm advisor, and Knowles Ryerson, Los Angeles county farm advisor, to view such systems in operation and the process of installation. Interest in the comparatively new method was manifested in that 65 machines, carrying over 200 growers, made the trip.

The morning was spent in viewing groves at La Habra, Orange county, the first stop being at the place of V. M. Tressler, where water is applied by means of stands five feet in height. On the Tressler place, located on a steep slope, the overhead system has been adapted as the only practicable way of applying water to the orange, lemon and avocado trees on the property.

H. E. Wahlberg telling a group of Orange county growers the apparent advantages of the overhead irrigation system. Take-on front drive of V. M. Tressler's citrus and avocado contour-planted grove, at La Habra, Orange county.

Because of the steep slope of the land and prevailing wind the stands are connected to the mains with rubber hosing until such time as the exact location for best results is determined. Mr. Tressler in addressing the growers stated that when first installed (the system still being in the experimental stage), the trees

Continued on page 182

[fol. 673] PLAINTIFFS' EXHIBIT No. 49

Proceedings of the Thirty-eighth Annual Meeting of the Florida State Horticultural Society, Held at Eustis, Fla., April 7, 8 and 9, 1925

Published by the Society, Office of Publication, DeLand, Florida

The Borax Treatment of Citrus Fruit for Prevention of Decay

H. R. Fulton, U. S. Bureau of Plant Industry, Washington, D. C.

Practically all of the decay of Florida citrus fruit after leaving the tree is either blue mold rot or stem end rot. The control of these two forms of rot is a factor of prime importance in the successful marketing of the crop of any season. For stem end rot five methods of control have proved more or less effective as follows (1) Pruning out of dead wood, the breeding ground for the two fungi that produce stem end rot. Pruning is more effective against Diplodia than Phomopsis stem end rot, but on the whole must be rated as probably not more than 50% effective. (2) Spraying the young fruit with bordeaux oil emulsion for melanose control cuts out about half of the stem-end rot in the matured fruit after picking, and is more effective against Phomopsis than against Diplodia. (3) Disbuttoning, properly carried out, is over 95% effective against both forms of stem-end rot, and may be accomplished during the precoloring process by maintaining humidity above 90% with temperature between 80° F. and 90° F. (4) Prompt handling. Both types of stem-end rot are relatively slow in starting on the fruit after picking, and seldom cause appreciable loss in less than ten days or two weeks from the [fol. 674] tree unless temperatures are abnormally high. (5) Low temperatures greatly prolong the development period of both types of stem-end rot, and are very effective in the successful marketing of fruit subject to this decay. To a large extent this merely postpones decay, and shifts the burden of loss to the buyer. It will be noted that two of the foregoing control measures, pruning out dead wood and spraying for melanose control, are in the hands of the

grower of the fruit; the other three measures, disbuttoning, prompt handling, and subjecting to low temperature, are in the hands of the shipper.

Effective control of blue mold rot in the past has involved three things: (1) careful handling at every stage to prevent the breaks in the skin necessary for blue mold infection. (2) keeping the surface of the fruit as dry as possible, so as not to have continuous moisture long enough for blue mold spores to sprout and grow. (3) temperatures low enough to greatly retard the growth of the blue mold fungus, which means about 45° F., some ten degrees lower than an effective temperature for stem-end rot control.

For a long time fruitless search has been made for a satisfactory chemical agent that will control these rots. For several years the U. S. Bureau of Plant Industry has been investigating blue mold control by fungicides, following a different line of attack from those previously used. It was found that dipping the citrus fruit in 5% solution of borax (40 pounds borax in 100 gallons water) protects it against blue mold decay to a marked degree. Leaving a certain amount of the borax sediment on the fruit makes the treatment more effective, and subsequent brushing of the surface-dry fruit, as in packing house polishing, does not materially lessen the effectiveness. Increase in temperature of the solution and prolonging the exposure to the warm borax up to the limit of tolerance of the fruit increase the effectiveness very materially. The treatment is highly effective even 24 to 36 hours after the fruit has been sub- [fol. 675] jected to blue mold infection. A very fortunate and entirely unexpected development in the testing of the borax treatment is its very high effectiveness against both types of stem-end rot, after either hot or cold applications.

Cold Borax Treatment

In packing house operations the simplest and least expensive type of installation is for the cold borax treatment. All that is necessary is a small tank with a conveyor, through which the fruit may pass after being washed and scrubbed, and before entering the drier; or else a sprinkling device that will wet the fruit thoroughly with the borax solution after it has been scrubbed and before it is dried. In the latter case, the borax spray is caught in a pan and re-

circulated by means of a rotary pump. The solution, if kept reasonably clean, may be used for a week or two without renewal. Attention must be given to maintaining its proper strength. In cool weather, if the temperature falls below 68° F., the saturation point will be lowered to less than 5% for borax, and it will be necessary to use some means of keeping the temperature above 68° F. in order to maintain a full 5% strength. If water brought in on the surface of the fruit from the scrubbers tends to dilute the solution, a slight addition of borax from time to time will be necessary to maintain the proper strength. Concentrations of solution up to 10% do not injure the fruit, but leave a too conspicuous sediment, and are only slightly more effective than 5% solution. With the 5% cold treatment the polishing brushes take off occasional blotches of unsightly sediment, and the fruit has a good appearance after treatment, even though the surface carries an inconspicous coating of fine borax crystals sufficient to protect against later infection. In extensive laboratory tests on commercially handled fruit of inferior grade, held after treatment at 70° F. with high humidity,—conditions that would give every chance for rot to develop,—it has been found on the average that something over 50% of the blue mold decay and almost 75% of stem-end rot are prevented, over a [fol. 676] two to three weeks' marketing period. These degrees of effectiveness have been fully maintained in commercial shipments. The cost is only a fraction of a cent a box. One dollar per car is ample to cover all costs of the cold borax treatment. About 50 packing houses have used it during the past season in Florida.

Hot Borax Treatment

Preliminary laboratory tests have shown increased effectiveness of the borax treatment with progressive rise in temperature when the fruits are allowed to remain for several minutes in the hot solution. For several years in California lemons and to some extent oranges, have been washed for four or five minutes in water at 115 to 120° F. for the control of brown rot. It was thought that this experience in California would be a fair guide for the tolerance of citrus fruits for the hot borax bath, and our first tests were made at 120° F. with exposure for five minutes.

The internal temperature of the fruit in such brief treatment was not greatly raised, and the quality of the fruit was not adversely affected. Under the rather moist holding conditions maintained in the tests so as to promote rot, the hot treated fruit maintained a normal plump appearance, with however a distinct surface deposit of sediment or gray bloom. This hot treatment increased the effectiveness to over 90% for blue mold rot, and to about 80% for both forms of stem-end rot. The hot borax treatment is being tried in two or three packing houses in this state. In some cases an "aged" appearance has developed in the fruit after hot treatment; it has been found advisable to try lowering the temperature to 106 or 108° F., and to remove some of the borax with a 2½% borax spray or a water spray as it leaves the borax tank. This procedure is being tried extensively in California. Experimental tests have shown that each of these changes is in the direction of lessened effectiveness of the hot treatment, and the combined result would probably give an effectiveness inter- [fol. 677] mediate between the cold borax dip and the 5-minute bath in 5% borax at 120° F. The fruit so treated has been arriving at market in a generally satisfactory condition, as has that from a number of packing houses in which the cold dip is used. Whether severe shipping conditions would show material difference between the cold and the moderately hot treatments remains to be seen. It is still too soon for a final conclusion as to the exact temperature and concentration and degree of removal of borax deposit that will give the highest degree of effectiveness with due regard to highly attractive appearance of the fruit on the market. It is not unlikely that discriminating buyers will not object to a little borax on the fruit for the same reason that some people like to have visible evidence that apples have been sprayed—to have assurance of good keeping quality.

An installation for the hot treatment must include a tank of sufficient size to give approximately 5 minutes in the hot borax solution; a device to keep the fruit properly submerged and to insure a slow enough passage through the solution; suitable heat piping in the tank, and a boiler or other means for supplying the heat. The cost is greater than for the cold treatment on account of more expensive installation, fuel, attention to operation and regulation, and

larger amount of borax thrown away in renewal of the solution, when necessary, in the larger tank. Even with these items figured in the hot borax treatment ought not to cost more than two or three dollars a car when the equipped unit is working at full capacity.

Under Florida conditions, with stem-end rot to be considered as well as blue mold rot, and with little difference between hot and cold treatments in effectiveness against the former, it may be that the cold treatment will meet most of the requirements for ordinary shipping conditions, and certainly offers a convenient and inexpensive means of trying out the method. Under very trying shipping conditions the added effectiveness of the hot borax treatment would certainly be desirable; but this treatment must not be [fol. 678] pressed to the point of market loss from sediment or aged appearance. Ordinary hard water as well as soft water has been used satisfactorily for the cold borax treatment. Even with the hot treatment it seems unlikely that chemical reactions taking place between the borax and the dissolved mineral salts in the water would materially lower the percentage of effective borax, or produce enough sediment to form an unusual objectionable surface deposit. There is some evidence that surface deposit sometimes becomes gradually more prominent with ageing of the solution in the tank after using a week or ten days, even in the cold treatment. To keep tab on the strength of solution, hydrometer and temperature readings are taken, and the corresponding borax percentage looked up in a reference table. An effective strength of solution must be maintained and excessive concentration avoided. Intelligent supervision is required for this.

It must be remembered that even small amounts of borax in the soil affect growing plants of various kinds to a serious degree, and the disposal of waste borax solution must be watched with this in mind. The addition of hydrated lime to the borax solution some hours before the tank is emptied will convert much of the soluble borax into an insoluble form and lessen the chance of its injuring vegetation.

Whether or not the borax treatment will completely replace any of the older methods of controlling either blue mold rot or stem-end rot remains to be seen. At its best it is not 100% perfect, and the part of wisdom is to go slowly

in modifying established methods of control and note carefully the effects under all sorts of conditions,—to regard this new chemical method of control as an additional fighting unit in the warfare against these destructive rots of citrus fruits. Its use gives promise of extending the market range for citrus fruit, and of increasing consumer-satisfaction, as well as of lessening losses from rot in transit.

[fol. 679] Member: I would like to ask about the drying of this fruit. Does the test show there is any difference in drying after the borax is used, and is there any difference between the hot and cold?

Dr. Fulton: If anything, the cold borax solution dries more rapidly than the water. The hot solution certainly dries very much more rapidly than water.

Mr. Warner: I would like to ask regarding the methods of heating that water. What methods have you?

Dr. Fulton: I am going to ask Mr. Andrews to answer that if he will.

Mr. Andrews: Recently I have been to California. It takes considerable heat to carry on 110° or 112° treatment. In the Winter Garden houses, for instance, we have as high as a 15 horsepower boiler, which on cold days is working to capacity to maintain 120 degrees. In California, where they have natural gas, they generally use low pressure steam boilers. There were about twenty houses using them, of maybe 5 to 8 and 10 H. P. It will develop that for a six car house you would have to have a 6, 8 or 10 H. P. boiler to hold the water at 106 or 108°, and be sure you are going to protect your fruit on a cold day.

Two or three things we have observed in a practical application might be of interest. The white deposit on fruit that Dr. Fulton speaks about. If we put borax through our washers we find the rolls get a little whitish appearance. Sometime ago in Winter Garden, the deposit was so bad that they were going to discount the fruit on the New York market on account of the white deposit. We had to spend a day to boil those rollers and get the mixture off. If you have a wooden roller, run the drier for 8 or 10 revolutions, and spray with warm water, and you get that deposit off.

We have found in buying borax—there is a fine pulverized form that you buy for household use. If you throw

that into a tank for the cold borax treatment, it takes a long time to dissolve. It is much better to take a crystal form one-quarter inch in diameter. Then the water can circulate [fol. 680] through the crystals, and they will dissolve away and go in the solution much quicker.

Member: This might be of interest. We put in a hot borax plant in December. Previous to putting it in we were getting on the average of 5% to 10% decay under ice, and since putting in the plant we have shipped in the neighborhood of 75 cars with less than 1% decay, using the hot treatment. It took exactly five minutes for the fruit to go through and in heating the solution to 105°, the fruit got in dry—it burned the fruit up. After shipping 8 or 10, we cut it down to 85° of 5% solution. That held up 14 days. One sample out of ten would be 100% perfect, and I have found only one decayed orange at the end of fourteen days in any sample that we have had. We never had any trouble with borax on the fruit, but we still get reports on its being aged and dry when only heated at 85°. At another house we tried the cold borax, with no results. In this house here, it is washed, and goes in at 85°, and from there into the drier and through the polisher.

At the Clearwater house, after trying out this cold borax solution, without results, I put in what is called an alkali special by-product. We were shipping under ice with decay, but since using that we ship getting 1% decay, while a neighboring house, shipping under ice, is getting more decay than we are.

I am still using one solution in one house, and the other in the other. In heating the water at Valrico I use two gasoline drums, with an ordinary cast-iron coil, and have a circulating pump to pump the water out and back into the vat. On a warm day, I keep water at 85°. I made a 5% solution, and at 85°, by using an ordinary hydrometer, I tested it with that, in order to find what I knew was 5% solution.

The other is about a 2% alkali Special; I buy it at Mr. Skinner's place at Dunedin.

Mr. Chase: I was in California the latter part of January or the first of February, and I visited some of the packing houses out there that are using the borax solution. [fol. 681] California fruit is troubled with blue mold. Our trouble comes mostly from stem-end decay, so we can't con-

fuse the California experiments with Florida eperiments. One of the big packing houses of the California Exchange was one of the first houses to make a trial test of the borax solution. Last August or September they shipped 37 cars and out of the 37 cars there were 30 cars that went through without any decay whatsoever. There was a 1% decay discovered in the balance 7 cars. Those cars moved under ventilation.

The U. S. Department of Agriculture had two very good men in charge of the work at that point—Mr. Lon Hawkins and Mr. Barger, and they gave me all their data, and showed me all their machinery and equipment. They advise a temperature of 110°, and they keep the solution hot. They were under the impression that it would be advisable to have the hot solution here, but from the experiments that have been carried on in Florida packing houses, and the appearance of fruit at destination, I am rather of the opinion that it would be rather dangerous for Florida to make use of the hot solution. I also am of the opinion that it is too hot. If it went up to 110°, which they thought in California would be the desirable temperature, I think it would be too hot. 85 degrees would be all right. They thought at that time it would be necessary to have a hot solution in order to bring about a penetration of the borax solution, but I have found out since that they have been unable to find any penetration. They are trying to determine now whether there is a penetration, and a benefit from that penetration.

There were a number of other interesting matters I ran across in California that would be of great interest to the Florida growers. I visited Mr. Shammel, at Riverside. Mr. Shammel, we all know, has done more in citrus bud selection than anyone else, I suppose, in this country. I ran across him first in 1911, when he was beginning his work. After that they permitted him to carry on some very extensive experiments in Riverside, and the results of those experi- [fol. 682] ments show that the bud runs through to the parent tree; that is if it has good qualities they are perpetuated in the bud; if they have bad they also are perpetuated in the bud. Mr. Shammel showed me some trees that were the result, purposely, of defects in the parent tree, that came out in the bud. If they were shy bearers, it showed up, in the bud. If they were extensive bearers it showed up in the bud, and I feel that the knowledge gained by Mr. Sham-

mel would be of inestimable value to the Florida Citrus Industry. I brought that matter up to Mr. Shammel to see if his services could not be assigned to Florida for a period, so we could get the benefit of his knowledge, and perfect some mistakes that I know are going to be very expensive, unless something along those lines is done. Mr. Shammel seemed to think that if possibly strong enough appeal went up to headquarters he could be transferred from California, and the Florida citrus industry would get the benefit, and I would like to see if something could not be done along those lines at this meeting.

Mr. Skinner: Prepare a resolution and bring it in a little later in the day, please.

Member: I would like to ask about the time during which the fruit is saturated—whether he has experimented with a lesser period.

Mr. Fulton: Yes, we have simply wet the fruit with a cold solution, and will bring just about as good results as soaking for four or five minutes, provided the wetting is thorough. With the hot solution it is necessary for the fruit to be in something like five minutes, in order to get the skin warmed up, and get the benefit from the temperature.

Mr. H. S. Skinner: What is the effect of the borax on the drying of the fruit? I believe he was answered that the fruit dried more readily with it than without it, and that is contrary from what we get from the machinery end. Complaints are that if we put borax on we can't get the fruit dry. I was wondering if Mr. Andrews had any experience [fols. 683 & 684] in the Winter Garden house on the drying end of it.

Mr. Andrews: With the cold borax I believe we have noticed that it dries a little bit slower; with the hot borax the heat that is applied to the skin of the orange furnishes the heat of evaporation, and while the Winter Garden drier is very inefficient on account of being rebuilt, we are able to get it dried, except on a very cloudy morning, but with the cold borax I believe there is cause for complaint on a little slower dry.

Dr. Fulton: In making my statement a while ago I was thinking about the drying where there is an equal amount of moisture. Ordinarily when the borax treatment is used I find the fruit comes in with more moisture on it, because ordinarily more or less of the surplus moisture is taken off.

Mr. Barney: Do you heat the air that you pass through the drier?

Mr. Andrews: It has been tried. Arcadia tries cooling the air, which serves the same purpose. They put lots of ice before the fan, and wring the moisture out before it goes in. Winter Garden now has a heating arrangement to heat the air.

Mr. Warner: I don't quite understand about the ageing effect.

Mr. Fulton: That ageing effect is puzzling us also. It is still in the investigation stage.

Mr. Allen: Does this borax in any way affect the eating qualities of the fruit?

Mr. Skinner: Not at all.

[fol. 685] PLAINTIFFS' EXHIBIT No. 50

Borax as a Disinfectant for Citrus Fruits

By William R. Barger and Lon A. Hawkins

(Contribution from Bureau of Plant Industry)

Reprinted from Journal of Agricultural Research

Vol. XXX, No. 2, Washington, D. C., January 15, 1925

Published by Authority of the Secretary of Agriculture, with the Cooperation of the Association of Land-grant Colleges

Washington: Government Printing Office, 1925

[fol. 686] Joint Committee on Policy and Manuscripts

For the United States Department of Agriculture: E. W. Allen, Chairman, Chief Office of Experiment Station; C. L. Marlatt, Chairman, Federal Horticultural Board, and Associate Chief, Bureau of Entomology; C. L. Shear,

Senior Pathologist in Charge, Plant Disease Survey and Pathological Collections.

For the Association of Land-grant Colleges: J. G. Lipman, Dean New Jersey College of Agriculture and Director of Experiment Station; H. W. Mumford, Dean Illinois College of Agriculture and Director of Experiment Station; S. B. Haskell, Director Massachusetts Experiment Station.

Editorial Supervision: M. C. Merrill, Assistant Director of Publications, in Charge of Scientific and Technical Manuscripts, U. S. Department of Agriculture.

All correspondence regarding articles from State Experiment Stations should be addressed to J. G. Lipman, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Published semimonthly on the first and fifteenth of each month. This volume will consist of twelve numbers and the Contents and Index.

Subscription price: Domestic, $4.00 a year, two volumes; Single numbers, 20 cents; Foreign, $5.00 a year, two volumes; Single numbers, 25 cents.

If separates are desired they should be ordered at the time the manuscript is sent to the printer; they will be supplied at cost.

Address all correspondence regarding subscriptions and purchase of numbers and separates to the Superintendent of Documents, Government Printing Office, Washington, D. C.

[fol. 687] Borax as a Disinfectant for Citrus Fruit[1]

By William R. Barger, Assistant Physiologist, and Lon A. Hawkins, Physiologist, Horticultural Investigations, Bureau of Plant Industry, United States Department of Agriculture

The use of disinfectants in washing citrus fruits has been a common practice in California for many years. In 1906

[1]Received for publication Aug. 31, 1924; issued April, 1925.

Smith[2] showed that the brown-rot of lemons caused by Pythiacystis citrophthora Smith and Smith, could be controlled by a solution of potassium permanganate, copper sulphate, or formalin in the wash water. Since then copper sulphate has been used to a considerable extent commercially. For fifteen or twenty years hot water and soap have been employed in washing both oranges and lemons, and for the past ten years a soap containing borax has been extensively used. It has also been a common practice in some packing houses to use a dilute solution of borax in the wash water in addition to the soap. Except in the case of brown-rot of lemons, there appears to be no data on the exact effect of these various disinfectants in the control of the fungous diseases of Citrus which gain entrance to the fruit in handling and harvesting operations and are particularly evident during transit and on the market.[3] To obtain more exact information upon the possibilities of controlling some of the common Citrus parasites such as blue mold, caused by Penicillium italicum Wehmer, and green mold, caused by Penicillium digitatum Sacc., a series of experiments was conducted in which some common and cheap disinfectants were used in the wash water. Since the results of these investigations were fairly definite and present a basis for further commercial application of disinfectants in the control of certain Citrus diseases, a preliminary presentation is here given.

The work was begun in California early in 1924, either Navel or Valencia oranges being used in all experiments described in this paper. In the first preliminary experiment, powdered boric acid U. S. P. and potassium alum Tech. were used. Navel oranges, which had been picked from four to six weeks, were prepared for the experiment by removing thin slices of skin from each fruit. Seventy-five fruits were immersed for five minutes in a solution of 2.5 per cent boric acid at a temperature of 120° F., two other lots of 75 each were treated, one by immersing in a

---

[2] Smith, R. E., and others. The Brown-rot of the Lemon. Calif. Agr. Exp. Sta. Bul. 190, 72 p., illus. 1907.

[3] Powell, G. H., and others. The Decay of Oranges While in Transit from California. U. S. Dept. Agr., Bur. Plant Indus. Bul. 123, 79 p., illus. 1908.

solution of 4.5 per cent powdered alum and the other in hot water only for five minutes at 120° F. After the fruits had been removed from the baths they were inoculated with spores of blue mold obtained from a decayed fruit. The fruit was dried, packed, and stored in a room having a temperature of about 70° F. and a humidity of about 90 per cent. After one week both the fruit treated with hot water and that treated with powdered alum solution showed 100 per cent decay caused by blue mold. The lot treated with boric acid showed only 2.5 per cent decay from blue mold and about the same percentage from green mold. Further holding of the lot showed some decay from what seemed to be Alternaria sp. or Pythiacystis sp. In this connection it is interesting to note that Smith[1] found that very dilute solutions of boric acid would not control Pythiacystis citrophtora on lemons.

This experiment indicated that boric acid offered very promising possibilities and that alum was apparently of no particular value in concentrations such as could safely be used in washing the fruit. Borax (technical grade) was later tested and found to be as effective as boric acid in controlling blue-mold decay, and, being much cheaper, was used in all later experiments. The investigation here described was concerned mainly with testing the efficiency of a 2.5 per cent solution of borax at various temperatures and with different methods of application in the control of blue and green mold which had been inoculated on the [fol. 688] surface of wounded fruit and in punctures similar to those made by stem or thorns.

The fruit was prepared for inoculation either by cutting thin slices of the rind just below the oil cells and into the white portion similar to the wound made by a clipper cut or by puncturing the rind with a knife to the depth of about 2 mm. The depth the knife was thrust into the fruit was controlled by wrapping tire tape around the blade so that it could penetrate the fruit only to the depth required. The inoculations were made by rubbing spores on the cut surface, where a portion of the rind was sliced away, and by dipping the knife in a mass of spores when making the wound by puncture. The spores for inoculating the fruit

[1] Smith, R. E. op. cit.

were obtained from decayed oranges. Since the greater part of this work was done under ordinary packing-house conditions and with the regular packing-house machinery, no attempt was made to get pure cultures of the fungi for making inoculations. Decayed oranges were selected, however, as the source of spores, because judging from the external character and color (1, 3), these seemed to furnish practically pure cultures of the fungi.[5] In many cases, undoubtedly, the fruit was inoculated from mixed cultures and there was especially in the controls considerable possibility of natural inoculations when the regular packing-house machinery was used in handling the fruit.

In the early experiments the procedure was to wound the fruit, treat it with a 2.5 per cent solution of borax, either by immersing or floating it in this solution, inoculating it by rubbing a finger dipped in the blue mold spores on the cut surface, drying in the air, wrapping, packing, and storing. The fruit was usually stored at about 70° F. with a humidity of about 90 per cent. Controls were prepared in exactly the same way except that instead of being treated with the borax solution they were treated with water only and inoculated with the fungi. At the end of one week the fruit was examined, the decayed fruits classified and removed, and the remaining sound fruits allowed to remain for the next inspection. When the fruit was immersed, it was held about 4 inches below the surface of the solution by a rack. When it was floated no weight was used, and it was allowed to float freely in the tank of solution, from one-eighth to one-tenth of the rind being exposed above the surface. The results of the experiments made with blue mold fungus on Valencia oranges are shown in Table I.

Table I shows that there is much more decay in the untreated fruit after one week than in any of the borax-treated lots. In the latter the best results were obtained at the higher temperatures and when the fruit was allowed to remain for four minutes or more in the solution. In no

[5] Thom, C. Cultural Studies of Species of Penicillium. U. S. Dept. Agr., Bur. Anim. Indus. Bul. 118, 109 p., illus. 1910.

case was there more than 4.5 per cent of blue mold in any of the lots treated at 120° F. except in the two lots sprayed with water after being treated with the borax solution. In these lots the decay caused by blue mold after one week was 6.1 and 7.8 per cent. Evidently for the best results the borax solution should be allowed to dry on the fruit. At the higher temperatures blue mold is apparently controlled as well by allowing the fruit to float in the borax solution as by immersing it. At the lower temperatures, however, floating did not give as good results as did immersion. In the lots of fruit injured by puncturing and inoculating in these wounds, practically as good control was obtained as when the wounds were superficial.

The results of the inspections after two weeks show some increase in the amount of blue mold present in the treated fruit, although in the lots treated at 120° for eight minutes there was in no case more than 5 per cent of blue mold decay. There was little increase in blue mold decay after five to seven weeks. The amount of decay caused by green mold was very much higher during the later inspections than at the first. This fungus is apparently not so easily controlled by borax as is the blue mold fungus. Results of a series of experiments on the treatment of Valencia oranges inoculated with green mold are shown in Table II. The spores for inoculating this fruit were obtained from decayed specimens which appeared to be affected only with green mold, although, of course, as in the case of blue mold there was probably some contamination.

An inspection of Table II corroborates the observation indicated by Table I, namely, that green mold is not readily controlled by treatment with this concentration of borax. In the lots of fruit wounded on the surface and immersed [fol. 689] there was no apparent infection from blue mold but at the end of five weeks 73 per cent or more of the fruit had decayed from what apparently was green mold. With the fruit inoculated by puncturing and immersion the results are not so striking; there is considerably more blue mold present, indicating contamination of the culture used for inoculation. The percentage of rot caused by green mold as shown by the later inspections is high in all cases, although it was above 50 per cent in only one case.

From the results of the experiments herein reported it is evident that blue mold rot, which causes so much damage to Citrus fruit in California, can be largely controlled by treating the fruit with a solution of borax. Much of the work described in this paper was done in the packing house and with equipment suitable for application in a commercial way. It remains, however, to make further experiments on a commercial basis, to determine the value of the treatment in actual shipping and marketing tests. While borax in the concentration used is not so effective in the control of green mold as in that of blue mold, it is probable that higher concentrations of borax or other disinfectants may be found which will be effectious against this fungus. Work along these lines is in progress.

---

[1] The question as to whether treatment with borax should be indicated by special label or otherwise for interstate shipment has not yet been determined.

(fol. 690) Table I.—Showing percentage of decay in Valencia oranges, wounded on surface or punctured, immersed or floated in a 2.5 per cent solution of borax, inoculated on the wounds with blue-mold spores, and held in a warm room at high humidity.

Treatment	Temperature of borax bath	Time	Number of fruit	Percentage of decay after— One week: Blue mold	One week: Green mold	Two weeks: Blue mold	Two weeks: Green mold	Five weeks: Blue mold	Five weeks: Green mold	Seven weeks: Blue mold	Seven weeks: Green mold
	°F	Minutes									
Control wounded and inoculated but not treated with borax			73	98.6	0						
			100	100.0							
			513	90.0							
			686			92.4	0				
			100	100.0							
Wounded on surface, immersed in borax solution and inoculated	73	4	100	13.0	17.0	14.0	65.0	14.0	84.0		
	73	8	83	0	0	0	15.3				
	120	3	224	4.4	2.6						
	120	3	459			9.3	32.4				
	120	3	224	4.5	0						
	120	4	75	2.6	2.6						
	120	4	15	0	6.6						
	120	4	395	2.2	1.2						
	120	4	972			12.7	36.0				
	120	4	485	2.3	0						

Wounded on surface, floated in borax solution and inoculated	73	4	100	41.0	16.0	42.0	48.0	42.0	54.0			
	120	8	423	0	0							
	120	8	488			4.9	25.8					
Wounded on surface, immersed in borax solution, inoculated, and rinsed with water	73	4	50	26.0	16.0	26.0	38.0	26.0	60.0			
	73	6	50	60.0	8.0	64.0	24.0	64.0	36.0			
Wounded on surface, immersed in borax solution, inoculated and sprayed with water	120	6	587	6.1	6.8							
	120	6	701	7.8		45.1	30.1					
Control punctured and inoculated; not treated with borax			250	83.6	0	84.8	0	86.0	0			
Wounded by puncturing, inoculated and immersed in borax solution	70	8	50	0	0	2.0	0	2.0	4.0	2.0	4.0	
	120	4	100	2.0	0	6.0	4.0	6.0	46.0	7.0	53.0	
	120	6	100	0	0	2.0	3.0	2.0	34.0	3.0	40.0	
	120	8	150	3.3	0.6	4.6	2.6	5.3	30.0	5.3	37.9	

Table II.—Showing percentage of decay in Valencia oranges, wounded on surface or punctured, immersed or floated in a 2.5 per cent solution of borax, inoculated with green mold spores, and held in a warm room at high humidity.

Treatment	Temperature bath	Time	Number of fruit	Percentage of decay after— One week: Blue mold	One week: Green mold	Two weeks: Blue mold	Two weeks: Green mold	Five weeks: Blue mold	Five weeks: Green mold	Seven weeks: Blue mold	Seven weeks: Green mold
	° F.	Minutes									
Control wounded on surface and inoculated, not treated with borax			100	80.0	20.0						
Wounded on surface and immersed in borax solution	67	4	100	0	27.0	0	97.0	0	99.0		
	67	8	100	0	15.0	0	92.0	0	95.0		
	120	4	100	0	24.0	0	92.0	0	98.0		
	120	8	100	0	2.0	0	50.0	0	73.0	0	80.0
Control wounded by puncturing, inoculated, not treated with borax			37	0	100.0						
Wounded by puncturing, inoculated and immersed in borax solution	73	4	100	11.0	2.0	15.0	2.0	18.0	24.0	19.0	28.0
	73	6	100	16.0	0	18.0	7.0	21.0	45.0	22.0	50.0
	70	8	46	0	8.7	0	48.0	0	84.8		
Same except treated by floating in borax solution	73	4	50	8.0	0	8.0	4.0	10.0	42.0	10.0	44.0
	73	6	50	14.0	0	18.0	4.0	18.0	26.0	18.0	32.0

[fol. 691] PLAINTIFFS' EXHIBIT NO. 51

October 10, 1925

The Florida Grower

Borax As a Preventive of Decay

Experiments Show It to Be of Great Value in Treatment of Citrus Fruit Shipments

By J. W. Andrews, Orlando, Florida

Commercial tests and laboratory experiments have demonstrated that borax and boracic acid have a marked control on blue mold, phomopsis and diplodia rot. These facts have a very important bearing on marketing problems and the increasing use of these compounds, especially the latter, is bound to play an important part in future packing house operations.

The borax of commerce is a compound of sodium, boron and oxygen which takes up ten molecules of water in solidifying. It is found in the soils of some parts of the west but is mainly derived from a compound of calcium, boron and oxygen which is abundant and easily mined. This fact, together with the low cost of chemicals necessary to change it to borax, gives us a product usually over 99 per cent pure and at a reasonable cost, ranging from 7 to 10 cents per pound, depending on quantity. It can be obtained in several forms ranging from finely powdered to crystals one-eighth inch in diameter, but for use in packing houses the "granulated," which screens about 10 to the inch, seems preferable as the finer is more liable to "cake" in the bottom of the tanks.

The use of borax and boracic acid as preventives against development of molds and decay has been known for over 50 years. In the late sixties it is known that it was used to preserve meats, either raw or cooked, and its use soon spread to preservation of fruits or vegetables. Records of that time show numerous combinations with other chemicals including alum, sodium phosphate, saltpeter, lye, glycerine, etc., in fact nearly all patent grants after the early

[fol. 692] seventies specified mixtures of several compounds. German and English patent records also indicate its popularity in those countries. The success attending the use of borax soon became the cause of its misuse with the preservatives which culminated in the passage of the Pure Foods and Drugs Act in the early part of the present century. In interpreting this act, the United States Department of Agriculture ruled that borax was prohibited in certain foodstuffs and restrictions were placed on its use on the surface of food products. This public health protective measure was aimed at the indiscriminate use of deleterious substances in prepared foods and has, of course, no bearing on the use of borax on the skin of citrus fruits as there is no indication that any of the borax reaches the edible part of the fruit.

Temperatures for Dissolving

At low temperatures, borax is not easily dissolved. As temperature of the water increases the rate at which it will enter into solution becomes less of a problem. In nearly all of the treatise on the use of borax a percentage of 5 is taken as a standard and it must be borne in mind that unless water is 68 degrees above it will not hold over 5 per cent borax. Below is given a table of solubility of borax at different temperatures ranging from freezing to boiling.

When the maximum temperature of the water is 33 degrees Fahrenheit, the maximum percentage of soluble matter is 2.5 per cent; 50 degrees, 3 per cent; 70 degrees, 3.2 per cent, 86 degrees, 7.1 per cent; 99 degrees, 10 per cent; 113 degrees, 14.2 per cent; 122 degrees, 18 per cent; 139 degrees, 22.2 per cent; 176 degrees, 45.3 per cent; 212 degrees, 65.1 per cent.

As it has been found that in percentages much below 5 the effectiveness of the borax bath falls rapidly, this table of solubility becomes of interest. As an example, let us take an instance where the borax strength has been made up to 5 per cent with water temperature of 75 degrees. If on a [fol. 693] cool night the tank temperature drops, it can still maintain the 5 per cent solution until it reaches a point of about 68 degrees. When this point is reached, borax will commence to crystallize out and deposit on the tank or ap-

paratus, weakening the solution. If the extreme of 50 degrees is reached, it is safe to assume from the table that but three per cent solution is available for the protection of fruit treated. The same effect would be produced if cold oranges were continuously dumped into the tank. This cooling and resultant weakening of solution is certain to have considerable effect on the results obtained remembering that once the borax crystallizes, it will probably redissolve quite slowly and leave the solution understrength for some time after the temperature has returned to normal. The writer has seen cases of where borax has been put into tanks in proper proportion to make a desired strength but where that strength has not been reached for a period of over 24 hours afterwards.

If heat could be supplied at times of low temperature, better results could be expected. Often it is not an expensive proposition to supply sufficient heat to overcome the trouble mentioned. If a house is operated with the ordinary type of kerosene or distillate engine, the exhaust could be directed into a chamber through which the solution could be circulated inside of coiled pipes. If operating with steam, a by-pass from the steam exhaust could be used. In one instance excellent results have been obtained by installing an electric hot water heater which could be used as desired.

How Much Borax Does It Take?

In the continuous process of handling fruit through a treating tank, borax is removed. Checks have shown that approximately 5 pounds of borax is carried out per car treated. If the fruit has been previously washed, water is at the same time being carried into the tank by the wet fruit. This action causes a weakening of the solution dependent on the number of cars treated, and necessitates [fol. 694] frequent checking of the solution's strength. Any good hydrometer can be used for this purpose or, in case none is available, the standard Brix used in fruit testing can be made to give fairly accurate indications. In using either of these, a table must be available to convert to percentage of borax. While the use of borax will probably bring forth some special type of instrument designed

to read percentages direct, the following table of approximate percentages is submitted if either of the two instruments mentioned must be used:

	Readings shown on Brix at temperatures indicated		
	70° F.	80° F.	90° F.
For 3% borax solution	4.0	3.5	3.0
For 4% borax solution	5.1	4.6	4.1
For 5% borax solution	6.2	5.7	5.2
For 6% borax solution	7.3	6.8	6.3

	Reading on hydrometer for use with liquids heavier than water at 70° F.
For 3% borax solution	1.015
For 4% borax solution	1.020
For 5% borax solution	1.025
For 6% borax solution	1.030

Very little of the borax carried out of the tank is left on the fruit when it reaches the packing bins. A large part of it drains off before the fruit reaches the drier and in the drier a large part is deposited on the rolls and cross belts. By the time the fruit reaches the polisher rolls it is covered with a very thin film of borax which is nearly all removed in the polishing process. This depositing of the powder necessitates frequent cleaning of machinery including drier rolls and cross belts, conveyor apparatus and even polisher rolls. If this is not done, borax will accumulate to the point where it is re-deposited on the fruit in its contact with machinery in the form of a very fine powder which will show enough to affect the sale of the fruit. If weekly cleanings are made, very little trouble will be experienced and by the use of hose and spray nozzle for a half hour after shutting [fol. 695] down, the machinery will be in good condition for the next week's operation.

Difference in Two Methods

After extensive research work, two methods of borax treatment appear to be of interest from a commercial point of view, they being commonly referred to as the "hot" and the "cold" treatment. The former method usually consists in subjecting the fruit to the action of a 5 per cent to 7 per

cent borax solution held at a temperature ranging from 110 to 120 degrees Fahrenheit the time varying from 4 to 8 minutes. The "cold" treatment is understood to be with solution of approximately 5 per cent at average operating temperatures and aiming to have the borax solution remain on the fruit for at least 5 minutes before becoming dried. Each method has its advantages as well as its disadvantages. The hot treatment unquestionably exerts a better control over blue mold but does so at a large increase in cost in the way of added equipment and operating expense. The cold borax treatment is very simple in its application, has a very good effect on control of blue mold and seems to be nearly as effective in the control of the stem-end decays as the hot treatment.

Nearly all of the California installations are equipped to handle the hot treatment, this being comparatively easy to install on account of the availability of natural gas throughout the growing sections and at a very reasonable price. Several of the California Fruit Growers Exchange houses in that state have installed an equipment designed in connection with research men from the United States Department of Agriculture. The fruit is washed, then dropped into a tank approximately 20 feet long which has paddle wheels for moving the fruit through the borax bath. After about five minutes of this treatment the fruit is taken on an elevator and delivered to a cross-belt which takes it to the drier and on through its usual operations.

[fol. 696] Use of Borax in Florida

Very few of the Florida installations have been for use of hot borax. In the score or more places where borax has been used there are several types of machines used in its application. These are about evenly divided between methods applying the solution in a spray over the fruit and those in which the fruit is dumped into the solution. While either method can be made very efficient, the method of dipping the fruit seems to have less chance for poor results. In nearly every packing house some point just beyond the washer can be found where fruit can be cross-belted to a borax tank, to be returned after the treatment. If this cannot be done the spray method can probably be installed.

By the use of three or four spray nozzles spaced a few feet apart, the solution can be circulated from some convenient tank placed below the floor level by use of a small centrifugal or "gear" pump and over the fruit as it passes along any conveyor. If this is done, galvanized iron sides and bottom can be arranged to catch the solution as it drains from the fruit and return it to the reservoir.

In the use of the heated solution, considerable fuel must be consumed to maintain the temperature of the bath. During the process of treating fruit it temperature rises from ten to eighteen degrees and this demands a good supply of heat depending, of course, upon the rate at which the fruit is given to the tank and upon its temperature upon entering the solution. In a commercial test during the past season at Winter Garden some very good determinations were made as to the amount of heat required. This installation consisted of an upright steam boiler which delivered steam at about 60 pounds to coils placed in the bottom of the borax tank. Without trying to tabulate results it can be said that to properly protect against failure of heat in cold weather, a five-car house should be equipped with a ten horse-power steam boiler or its equivalent in heating value. This figure of approximately 2 horsepower per car capacity would probably hold in general practice, becoming comparatively [fol. 697] less as the capacity of the house was increased. While the theoretical figures for the work to be done do not indicate such a large supply of heat, the losses incident to a large, open tank and the long pipe lines necessary to convey the steam to the house have shown in practical operation that the estimate given is none too high for proper treatment during heavy packing periods in our cooler weather. The large amount of heat required makes the use of electricity entirely out of the question with rates as they prevail at present.

How to Charge Borax Tank

In originally charging a borax tank with solution or replenishing its supply, considerable trouble is often experienced due to the slowness with which the borax enters into solution. If the borax is thrown into the tank and there is no attempt made to stir the mixture, the solution will build

up very slowly. One of the most efficient ways to charge a tank is to place a barrel nearby with an overflow pipe, properly screened, leading to the tank. A three-quarter inch hose without nozzle should then be fastened to the bottom of the barrel so that water can be supplied at the bottom. If the barrel is then filled to within a foot of the top with granulated borax, the water supply will be forced to work its way upward through a large mass of borax, finally draining, through the overflow into the tank. This system insures that the overflow will deliver to the borax tank a saturated or nearly saturated solution of borax, this percentage depending on the temperature of the water being supplied. By occasionally replenishing the borax supply in the mixing barrel the process of filling becomes an easy task and, as the temperature of our deep well waters is usually just above 70 degrees, the percentage desired for treatment will be approximately that which is delivered to the tank.

If the writer has appeared to emphasize proper strength of solution and thorough application, it has been intentional on his part. The one aim of the borax treatment is [fol. 698] to incorporate borax into the small injuries and about the stems of the fruit in order to kill organisms which cause decay. If this is not done, any money used in an attempt to do it is wasted, while if it is done, good returns are sure to come from the investment. Research has proved what this treatment can do for the grower; what it will do for the industry remains for the industry to demonstrate.

[fol. 699] PLAINTIFF'S EXHIBIT No. 52

The Cultivation of Citrus Fruits

By H. Harold Hume

New York: The Macmillan Company: 1926

All rights reserved

[fol. 700] Citrus Diseases

of stem-end rot is more difficult. While the value of careful and thorough pruning out of all the dead wood has been

questioned, it is of considerable assistance. In spring, between April 1 and 10, in most parts of Florida, the trees should be sprayed thoroughly with bordeaux mixture (3-3-50), with one per cent oil, as oil emulsion. This spraying should be timed as nearly as possible to a date shortly after the blooms have dropped. Generally this will give good commercial control. If the disease has gained a strong foothold, it may be wise to make a second application between May 1 and 10. This schedule, if carefully followed for a few seasons, should reduce the disease to a point at which it will give very little trouble, even though there may have been a severe attack.

The removal of the buttons from fruit by gassing, after it has been gathered for market, as has been shown by Winston, Fulton, and Bowman, very materially reduces the losses from stem-end rot. The handling of the fruit at low temperatures is also of material assistance, and precooling and shipment under refrigeration will still further eliminate losses from this cause.

Ripe Fruit Rots—Green Mold (Penicillium digitatum Sacc.) and Blue Mold (Penicillium italicum Weh.).

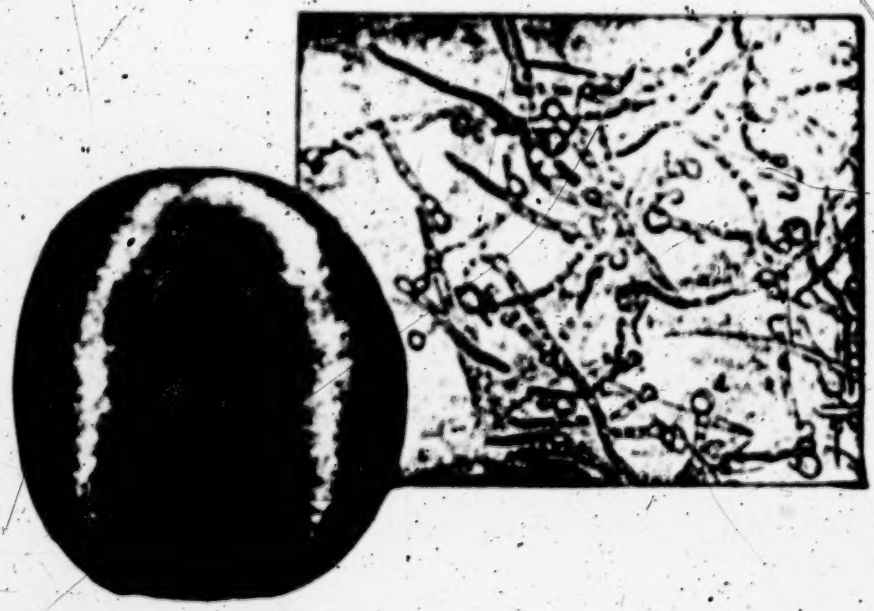
During the process of picking and preparing for market, citrus fruits are sometimes injured slightly. The cell structure of the rind is broken into and the blue and green molds gain entrance. Usually one or the other, or both, are present in every packing-house and grove in the citrus districts. Weather and growth conditions add to the difficulties. Sometimes they may gain entrance through thorn-pricks or branch injuries before the fruit is gathered.

During the last quarter of a century or more, attempts have been made to reduce the damage to fruit by ripe rots. The favorite plan has been to wash or immerse the fruit in a solution containing some substance that would destroy the spores of the rot and kill the mycelium, if not too deep [fols. 701 & 702] in the fruit tissues. Copper sulfate, iron sulfate, permanganate of potash, formalin, and potassium alum have been used with some measures of success. On the whole, the results have not been satisfactory enough to bring about the general use of any of these substances. Practically all citrus fruits are washed before packing, and the addition to the wash-water of any substance which will

reduce damage by ripe rots is simple. No change in packing house procedure would be required.

More recently, Barger and Hawkins[1] have secured results which indicate that blue mold may be controlled largely and economically by immersing citrus fruits in a 2.5 per cent borax solution before packing. Further experiments may justify the use of borax in a large way. The protection of fruit against some decay causing spores between packing and consumption is entirely feasible. Under no conditions, however, can immersion in a fungicidal solution be expected to take the place of careful handling of fruit during picking and packing.

FIG. 215. Blue mold on orange. Right, germinating blue-mold spores (greatly enlarged).



[1] Barger, W. R., and Hawkins, L. A. Borax as a Disinfectant for Citrus Fruits. Journal of Agricultural Research, Vol. XXX, No. 2, pp. 189-192, Washington, D. C., Jan. 15, 1925.

[fol. 703] PLAINTIFF'S EXHIBIT No. 53

Patented Oct. 20, 1925. 1,557,757

United States Patent Office

Harry R. Fulton and John J. Bowman, of Washington, District of Columbia, Dedicated, by Mesne Assignments, to the People of the United States

Process for Prevention of Decay in Fruits and Vegetables

No Drawing. Application Filed July 9, 1925. Serial No. 42,552

(Granted under the Act of March 3, 1883; 22 Stat. L. 625)

To all whom it may concern:

Be it known that we, Harry R. Fulton and John J. Bowman, citizens of the United States of America and employees of the United States Department of Agriculture, residing at Washington, District of Columbia, whose post-office address is Department of Agriculture, Washington, District of Columbia, have invented a new and useful Process for the Prevention of Decay in Fruits and Vegetables, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the United States, and its officers and employees, and by any person in the United States without the payment to us of any royalty thereon. We hereby dedicate the same to the free use of the Government and the people of the United States.

The object of this invention is to prevent the development of decay in citrus and other fruits and vegetables during the process of marketing, especially the prevention of the forms of decay of citrus fruits known as stem-end rot and blue-mold rot.

Stem-end rot of citrus fruits is caused by either of two fungi, known as Phomopsis citri and Diplodia natalensis. The fruit apparently becomes contaminated or incipiently infected with these fungi while still on the trees, but actual

decay does not set in until some days or weeks after the fruit has been removed from the trees in the process of marketing. Up to the present time control measures for these two stem-end rots have included one or more of the following procedures: (1) Keeping down sources of infection in the orchards by pruning out dead wood that harbors the two casual fungi; (2) spraying the young fruit with a suitable fungicide, such as Bordeaux mixture, so as to protect it against infection; (3) exposing the fruit after picking to certain gases, such as ethylene gas, or the fumes from imperfect combustion of gasolene or kerosene, under conditions of high humidity and temperature, in such way as to cause a loosening and shedding of the small portion of stem, with the calyx and receptacle, commonly called the "button," which is usually left attached to the fruit proper in the ordinary methods of clipping the citrus fruit from the trees. Most of the stem-end rot infection seems to enter the fruit through, or in the immediate vicinity of this button, and its removal effectively prevents stem-end rot; (4) refrigerating, precooling, or otherwise keeping the temperature of the fruit low enough to retard and so prevent the development of stem-end rot during a reasonable marketing period.

Blue-mold rot of citrus fruits is commonly caused by either of two fungi, known as Penicillium digitatum and Penicillium italicum. The methods now in general use for the control of blue-mold rot comprise the following: (1) careful handling of the fruit during the picking, packing, and market handling so as to avoid any wounds or breaks in the skin of the fruit through which the blue-mold rot fungus might gain entrance and set up infection; (2) keeping the surface of the fruit as dry as possible so as not to have continuous moist conditions long enough for the blue-mold spores to germinate and set up infection; (3) refrigerating, precooling, or otherwise keeping the temperature of the fruit low enough to retard and so prevent the development of blue-mold rot during a reasonable marketing period.

The present invention controls or reduces liability to loss from stem-end rot by applying to the fruit and leaving upon its surface a sufficient residue of certain chemicals that have an inhibiting or destroying effect on the fungi causing

stem-end rot, as well as upon other fungi causing decay of citrus and other fruits, as well as other perishable vegetable products, such as blue-mold rot, anthracnose rot, blossom-end rot. These chemicals are especially suitable for the practical control of various decays because of (1) their antiseptic or inhibitory action on the fungi causing the rots; (2) their ability to go into solution in any surface moisture sufficient for causing germination of spores of any of these rot organisms: (3) their ability to wet the surface, and adhere thereto and penetrate to some extent into the [fol. 704] tissues of the fruits; (4) their non-injurious effect on the fruit itself; (5) their non-toxic properties for persons consuming the fruit.

The chemicals that we have found to be effective and useful for this purpose are alkaline hydroxides, such as lithium hydroxide, sodium hydroxide and potassium hydroxide.

The method of treatment consists essentially in applying a solution of effective strength of any one of the chemicals in question, or a combination of them, to the fruit during the process of packing the fruit for marketing, and allowing a sufficient residue to remain on the surface of the fruit. The application may be made by means of a spraying device that will wet the fruit thoroughly with the solution after it has been washed in the usual way, or without being washed, and before it passes into the drying unit, the surplus spray drip being caught in a suitable tank or pan under the conveyor, and recirculated by means of a pump, or the fruit may be caused to dip in or be carried through a vat or tank in which the solution of effective strength is contained, the duration of the passage through such tank being sufficiently long to give effective results, usually from a fraction of a minute up to four or five minutes. Solutions of the chemicals named are effective at temperatures at which water is ordinarily used in citrus packing houses, namely from about 65° F. to about 85° F., and remain effective at higher temperatures up to the maximum that is safe for citrus fruit, namely up to about 120° F., and there is a gradual increase in effectiveness with increasing temperature. It is therefore advantageous to apply these solutions warm, at temperatures up to about 120° F., and in such case it would be advantageous to give rather long exposures, of about five minutes, in tanks specially equipped with steam pipes, hot

water pipes, electric immersion heaters, or pipes for circulating the chemical solution itself through coils in a suitable heater, or by other means for supplying and maintaining an adequate supply of heat. Any of the solutions may also be applied to the fruit as it passes over the scrubbing brushes in the various types of washers in ordinary use, by simply keeping such brushes wet with the solution.

The strength of solution for effective results also varies within rather wide limits for each chemical, depending somewhat on the conditions of infection encountered by the fruit subsequent to treatment. Under less severe conditions of infection a weaker strength might prove as effective as would a greater strength of solution under more severe conditions of infection. In general, it may be stated that these chemicals are effective in aqueous solutions ranging in strength between ¾% and 5% by weight, but in some cases and under some conditions an effective strength may be less than ¾% or strengths greater than 5% may be used without detriment to the fruit. However, tests made in the development of this invention have shown each of the specified chemicals to be effective at some strength within the range indicated.

The specific advance over other methods previously used consists in leaving on fresh fruit or vegetables as prepared for market a surface residue of the above-mentioned inhibiting chemicals that will effectively check the development of rot fungi over an extended marketing period.

We claim:

1. A process for preparing fresh fruits and vegetables for market which comprises the application to the surface of such articles of a solution of an alkaline hydroxide, to retard the growth or development of the organisms causing stem-end rot, blue-mold rot or other forms of decay.

2. A method for the prevention of decay of fruits and vegetables consisting in the treatment of such articles with a solution comprising lithium hydroxide.

Harry R. Fulton, John J. Bowman.

[fol. 705] PLAINTIFFS' EXHIBIT No. 54

Patented Oct. 20, 1925. 1,557,758

United States Patent Office

Harry R. Fulton and John J. Bowman, of Washington, District of Columbia, Dedicated, by Mesne Assignments, to the People of the United States

Process for Prevention of Decay in Fruits and Vegetables

No Drawing. Original Application Filed July 9, 1925, Serial No. 42,552. Divided and This Application Filed September 11, 1925. Serial No. 55,862

(Granted under the Act of March 3, 1883; 22 Stat. L. 625)

To all whom it may concern:

Be it known that we, Harry R. Fulton and John J. Bowman, citizens of the United States of America, and employees of the United States Department of Agriculture, residing at Washington, District of Columbia, whose post-office address is % Department of Agriculture, Washington, District of Columbia, have invented a new and useful Process for the Prevention of Decay in Fruits and Vegetables, of which the following is a specification.

This application is a divisional application of the application for a patent by the same parties, which bears Serial Number 42,552 and filing date July 9, 1925, entitled Process for the prevention of decay in fruits and vegetables.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the United States, and its officers and employees, and by any person in the United States without the payment to us of any royalty thereon. We hereby dedicate the same to the free use of the Government and the people of the United States.

The object of this invention is to prevent the development of decay in citrus and other fruits and vegetables during the process of marketing, especially the prevention

of the forms of decay of citrus fruits known as stem-end rot and blue-mold rot.

Stem-end rot of citrus fruits is caused by either of two fungi, known as Phomopsis citri and Diplodia natalensis. The fruit apparently becomes contaminated or incipiently infected with these fungi while still on the trees, but actual decay does not set in until some days or weeks after the fruit has been removed from the trees in the process of marketing. Up to the present time measures for these two stem-end rots have included one or more of the following procedures: (1) Keeping down sources of infection in the orchards by pruning out dead wood that harbors the two causal fungi; (2) spraying the young fruit with a suitable fungicide, such as Bordeaux mixture, so as to protect it against infection; (3) exposing the fruit after picking to certain gases, such as ethylene gas, or the fumes from imperfect combustion of gasolene or kerosene, under conditions of high humidity and temperature, in such way as to cause a loosening and shedding of the small portion of stem, with the calyx and receptacle, commonly called the "button", which is usually left attached to the fruit proper in the ordinary methods of clipping the citrus fruit from the trees. Most of the stem-end rot infection seems to enter the fruit through, or in the immediate vicinity of this button, and its removal effectively prevents stem-end rot; (4) refrigerating, precooling, or otherwise keeping the temperature of the fruit low enought to retard and so prevent the development of stem-end rot during a reasonable marketing period.

Blue-mold rot of citrus fruits is commonly caused by either of two fungi, known as Penicillium digitatum and Penicillium italicum. The methods now in general use for the control of blue-mold rot comprises the following: (1) Careful handling of the fruit during the picking, packing, and market handling so as to avoid any wounds or breaks in the skin of the fruit through which the blue-mold rot fungus might gain entrance and set up infection; (2) keeping the surface of the fruit as dry as possible so as not to have continuous moist conditions long enough for the blue-mold spores to germinate and set up infection; (3) refrigerating, precooling, of otherwise keeping the temperature of the fruit low enough to retard and so prevent the devel-

opment of blue-mold rot during a reasonable marketing period.

The present invention controls or reduces liability to loss from stem-end rot by applying to the fruit and leaving upon its surface a sufficient residue of certain chemicals that have an inhibiting or destroying effect on the fungi causing stem-end rot, as well as upon other fungi causing decay of citrus and other fruits, as well as other perishable vegetable products, such as blue-mold rot, anthracnose rot, blossom-end rot. These chemicals are especially suitable for the practical control of various decays because of (1) their antiseptic or inhibitory action on the fungi causing the rots; (2) their ability to go into solution in any surface moisture sufficient for causing germina- [fol. 706] tion of spores of any of these rot organisms; (3) their ability to wet the surface, and adhere thereto and penetrate to some extent into the tissues of the fruits; (4) their non-injurious effect on the fruit itself; (5) their non-toxic properties for persons consuming the fruit.

The chemicals that we have found to be effective and useful for this purpose are lithium salts of strong acids, (a strong acid being one that possesses high power of ionization, such as sulphuric acid, hydrochloric acid, nitric acid, and hydrobromic acid), examples of such effective salts being lithium sulphate, lithium nitrate, lithium bromide, and lithium chloride.

The method of treatment consists essentially in applying a solution of effective strength of any one of the chemicals in question, or a combination of them, to the fruit during the process of packing the fruit for marketing and allowing a sufficient residue to remain on the surface of the fruit. The application may be made by means of a spraying device that will wet the fruit thoroughly with the solution after it has been washed in the usual way, or without being washed, and before it passes into the drying unit, the surplus spray drip being caught in a suitable tank or pan under the conveyor, and recirculated by means of a pump, or the fruit may be caused to dip in or be carried through a vat or tank in which the solution of effective strength is contained, the duration of the passage through such tank being sufficiently long to give effective results, usually from a fraction of a minute up to four or five minutes. Solutions of the chemicals named are effective at tempera-

tures at which water is ordinarily used in citrus packing houses, namely from about 65° F. to about 85° F. and remain effective at higher temperatures up to the maximum that is safe for citrus fruit, namely to about 120° F., and there is a gradual increase in effectiveness with increasing temperature. It is therefore advantageous to apply these solutions warm, at temperatures up to about 120° F., and in such case it would be advantageous to give rather long exposures, of about five minutes, in tanks specially equipped with steam pipes, hot water pipes electric immersion heaters, or pipes for circulating the chemical solution itself through coils in a suitable heater, or by other means for supplying and maintaining an adequate supply of heat. Any of the solutions may also be applied to the fruit as it passes over the scrubbing brushes in the various types of washers in ordinary use, by simply keeping such brushes wet with the solution.

The strength of solution for effective results also varies within rather wide limits for each chemical depending somewhat on the conditions of infection encountered by the fruit subsequent to treatment. Under less severe conditions of infection a weaker strength might prove as effective as would a greater strength of solution under more severe conditions of infection. In general, it may be stated that these chemicals are effective in aqueous solutions ranging in strength between ¾% and 5% by weight, but in some cases and under some conditions an effective strength may be less than ¾%, or strengths greater than 5% may be used without detriment to the fruit. However, tests made in the development of this invention have shown each of the specified chemicals to be effective at some strength within the range indicated.

The specific advance over other methods previously used consists in leaving on fresh fruit or vegetables as prepared for market a surface residue of the above mentioned inhibiting chemicals that will effectively check the development of rot fungi over an extended marketing period.

We claim:

1. A process for preserving fresh fruits and vegetables for market which comprises the application to the surface of such articles of a solution of a salt of lithium in which the lithium base is combined with a strong acid radical, to

retard the growth or development of the organisms causing stem-end rot, blue-mold rot, and other forms of decay.

2. A method for the prevention of decay of fruits and vegetables consisting in the treatment of such articles with a solution comprising a halide of salt of lithium.

3. A method for the prevention of decay of fruits and vegetables consisting in the treatment of such articles with a solution comprising lithium chloride.

Harry R. Fulton, John J. Bowman.

[fol. 707] PLAINTIFF'S EXHIBIT No. 55

(Here follows drawing, side folio 708)

[fol. 709] Patented Nov. 3, 1925. 1,559,733

United States Patent Office

William R. Barger, William V. Hukill, and Lon A. Hawkins, of Washington, District of Columbia, Dedicated, by Mesne Assignments, to the Citizens of the United States.

Apparatus for the Treatment of Fruit with Antiseptics for the Prevention of Decay

Application Filed February 21, 1925. Serial No. 10971

(Granted under the Act of March 3, 1883; 22 Stat. L. 625)

To all whom it may concern:

Be it known that we, William R. Barger, William V. Hukill, and Lon A. Hawkins, citizens of the United States of America, and employees of the United States Department of Agriculture, residing at Washington, D. C., have invented a new and useful Apparatus for the Treatment of Fruit with Antiseptics for the Prevention of Decay, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the

707-708

PLAINTIFFS' EXHIBIT NO. 55

Nov. 3 1925. 1,559,733

W. R. BARGER ET AL

APPARATUS FOR THE TREATMENT OF FRUIT WITH ANTISEPTICS FOR THE PREVENTION OF DECAY

Filed Feb. 21, 1925

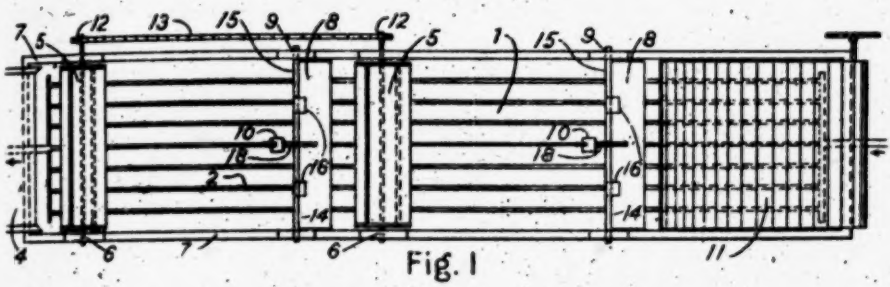


Fig. 1

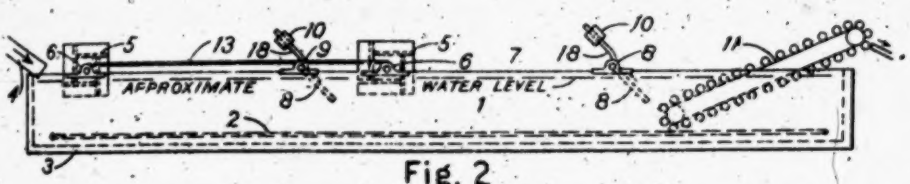


Fig. 2

Fig. 3

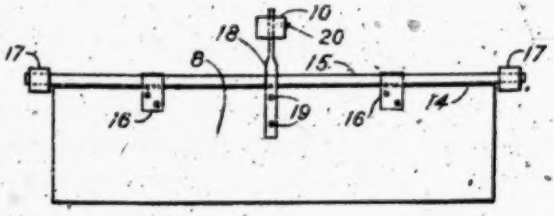


Fig. 4

Joint Inventors

William R. Barger

William W. Hukill

Lorne A. Hawkins

Fay R. W. Williams, C. W. Boyle, P. D. Cornish & J. Sachs
Attorneys

United States or any of its officers or employees in the prosecution of work for the Government, or any person in the United States, without payment to us of any royalty thereon.

The invention is shown in the accompanying drawing consisting of 4 figures in which

Figure 1 represents a plan view of the entire apparatus.

Figure 2 represents a side elevation in section of the apparatus.

Figure 3 represents a paddle wheel which is a part of the apparatus.

Figure 4 represents a baffle which is also a part of the apparatus.

The apparatus consists of a tank 1 constructed of suitable materials such as galvanized iron, and having dimensions depending upon the amount of fruit to be put through it in a given time, which is adapted to receive an antiseptic such as a solution of borax, in which the fruit is to be submerged. This solution is heated by a steam coil 2 of sufficient capacity to raise the temperature of the solution in the tank from 60° to 120° in one-half hour. This steam coil 2 is placed in the bottom 3 of the tank 1 and may extend throughout the entire length of the tank. Steam is supplied to the coil 2 in any conventional manner. The tank 1 is equipped with a gravity feed chute 4 for delivering the fruit to the tank 1; two revolving paddle wheels 5 held in place by bearings 6 bolted to the sides 7 of the tank 1 for submerging the fruit in the solution; two baffles 8 suspended from bearings 9 bolted to the sides 7 of the tank 1 and equipped with counter-weights 10 for regulating the speed of the fruit through the tank and thus determining the length of time the fruit is held in the solution; and an elevator 11 operated by a motor (not shown or other suitable means, for removing the fruit from the tank after the same has been treated with the antiseptic. The paddle wheels 5 are equipped with sprockets 12, a chain 13 extending between said sprockets and motion is imparted thereto by any desired means (not shown). The baffles 8 are made of boards at the upper edges 14 of which are affixed rods 15 by means of clamps 16, nuts 17 being attached to the ends of the rods 15 so as to hold the baffles 8 in position in bearing 9. The counter-weights 10 are supported by bent arms 18 which are in turn attached by rivets 19 to the upper edges

14 of the baffles 8. The counter-weights 10 are adjustable to any desired position on the arms 18, a set-screw 20 being employed for this purpose.

Operation.—In actual operation the fruit is fed into the tank 1 at one end through the gravity feed chute 4 and is immediately submerged by one of the paddle wheels 5, passes on to one of the baffles 8 and is held there until the fruit is several layers deep across the tank 1 or until it develops sufficient pressure to tilt the baffle 8 so that the lower layers of oranges may pass thereunder. The fruit passing into the tank 1 over the gravity shoot 4 is moved along by the paddle wheel 5 until it reaches the first baffle board 8; it remains there until the pressure of the fruit from the rear is sufficient to overcome the resistance of the baffle board 8, together with its counterweight 10, when it tips the baffle board and passes beneath it in turn to be moved forward by the second paddle wheel 5, when the process is repeated until the fruit is forced beneath the second baffle board 8 where it reaches the elevator 11 which delivers it to the drier (not shown). The rate at which the oranges pass through the tank 1, and the length of time they remain in the solution is [fol. 710] thus regulated by the rate at which they are fed into the tank and the position of the counter-weights 10 on the baffles 8.

We claim:

An apparauts intended for use in treating fruit with antiseptics, comprising a tank, containing an antiseptic solution, a chute for feeding the fruit to be treated into said tank, a steam coil in said tank for heating the antiseptic solution, paddle wheels in said tank for submerging the fruit in the solution, and, adjacent to said paddle wheels, baffles adapted to control the speed of the movement of the fruit throughout the length of the tank, and an elevator at the opposite end of the tank from the aforesaid chute adapted for the removal of the fruit from the tank.

William R. Barger, William V. Hukill, Lon A. Hawkins.

[fol. 711] PLAINTIFFS' EXHIBIT No. 56

Patented Nov. 10, 1925. 1,560,558

United States Patent Office

Harry R. Fulton and John J. Bowman, of Washington, District of Columbia Process for Prevention of Decay of Citrus Fruits

No Drawing. Application Filed September 11, 1925. Serial No. 55,861

(Granted under the Act of March 3, 1883; 22 Stat. L, 625)

To all whom it may concern:

Be it known that we, Harry R. Fulton and John J. Bowman, citizens of the United States of America, and employees of the United States Department of Agriculture, residing at Washington, D. C., whose post-office address is % Department of Agriculture, Washington, D. C., have invented a new and useful Process for the Prevention of Decay of Citrous Fruits, of which the following is a specification.

This application is a continuation in part of the application for a patent by the same parties, which bears Serial Number 42,552 and filing date July 9, 1925, entitled Process for the prevention of decay in fruits and vegetables.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the United States, and its officers and employees, and by any person in the United States without the payment to us of any royalty thereon. We hereby dedicate the same to the free use of the Government and the people of the United States.

The object of this invention is to prevent the development of decay in citrous and other fruits and vegetables during the process of marketing, especially the prevention of the forms of decay of citrous fruits known as stem-end rot and blue-mold rot.

Stem-end rot of citrous fruits is caused by either of two fungi, known as Phomopsis citri and Diplodia natalensis The fruit apparently becomes contaminated or incipiently infected with these fungi while still on the trees, but actual decay does not set in until some days or weeks after the fruit has been removed from the trees in the process of marketing. Up to the present time control measures for these two stem-end rots have included one or more of the following procedures: (1) Keeping down sources of infection in the orchards by pruning out dead wood that harbors the two causal fungi: (2) spraying the young fruit with a suitable fungicide, such as Bordeaux mixture, so as to protect it against infection; (3) exposing the fruit after picking to certain gases, such as ethylene gas, or the fumes from imperfect combustion of gasolene or kerosene, under conditions of high humidity and temperature, in such way as to cause a loosening and shedding of the small portion of stem, with the calyx and receptacle, commonly called the "button," which is usually left attached to the fruit proper in the ordinary methods of clipping the citrous fruit from the trees. Most of the stem-end rot infection seems to enter the fruit through, or in the immediate vicinity of this button, and its removal effectively prevents stem-end rot; (4) refrigerating, precooling, or otherwise keeping the temperature of the fruit low enough to retard and so prevent the development of stem-end rot during a reasonable marketing period.

Blue-mold rot of citrous fruits is commonly caused by either of two fungi, known as Penicillium digitatum and Penicillium italicum. The methods now in general use for the control of blue-mold rot comprise the following: (1) Careful handling of the fruit during the picking, packing, and market handling so as to avoid any wounds or breaks in the skin of the fruit through which the blue-mold rot fungus might gain entrance and set up infection; (2) keeping the surface of the fruit as dry as possible so as not to have continuous moist conditions long enough for the blue-mold spores to germinate and set up infection; (3) refrigerating, precooling, or otherwise keeping the temperature of the fruit low enough to retard and so prevent the development of blue-mold rot during a reasonable marketing period.

The present invention controls or reduces liability to loss from stem-end rot by applying to the fruit and leaving upon its surface a sufficient residue of certain chemicals that have an inhibiting or destroying effect on the fungi causing stem-end rot, as well as upon other fungi causing decay of citrous and other fruits, as well as other perishable vegetable products, such as blue-mold rot, anthracnose rot, blossom-end rot. These chemicals are especially suitable for the practical control of various decays because of (1) their antiseptic or inhibitory action on the fungi causing the rots; (2) their ability to go into solution in any surface moisture sufficient for causing germination of spores of any of these rot organisms; (3) their ability to wet the surface, and adhere thereto and penetrate to some extent into the tissues of the fruits; (4) their non-injurious effect on [fol. 712] the fruit itself; (5) their non-toxic properties for persons consuming the fruit.

The chemicals that we have found to be effective and useful for this purpose are alkaline carbonates, such as lithium carbonate, sodium carbonate, sodium bicarbonate, potassium carbonate, potassium bicarbonate, and ammonium carbonate.

The method of treatment consists essentially in applying a solution of effective strength of any one of the chemicals in question, or a combination of them, to the fruit during the process of packing the fruit for marketing, and allowing a sufficient residue to remain on the surface of the fruit. The application may be made by means of a spraying device that will wet the fruit thoroughly with the solution after it has been washed in the usual way, or without being washed, and before it passes into the drying unit, the surplus spray drip being caught in a suitable tank or pan under the conveyor, and recirculated by means of a pump, or the fruit may be caused to dip in or be carried through a vat or tank in which the solution of effective strength is contained, the duration of the passage through such tank being sufficiently long to give effective results, usually from a fraction of a minute up to four or five minutes. Solutions of the chemicals named are effective at temperatures at which water is ordinarily used in citrus packing houses, namely,

from about 65° F. to about 85° F. and remain effective at higher temperatures up to the maximum that is safe for citrous fruit, namely up to about 120° F., and there is a gradual increase in effectiveness with increasing temperature. It is therefore advantageous to apply these solutions warm, at temperatures up to about 120° F., and in such case it would be advantageous to give rather long exposures, of about five minutes, in tanks specially equipped with steam pipes, hot water pipes, electric immersion heaters, or pipes for circulating the chemical solution itself through coils in a suitable heater, or by other means for supplying and maintaining an adequate supply of heat. Any of the solutions may also be applied to the fruit as it passes over the scrubbing brushes in the various types of washers in ordinary use, by simply keeping such brushes wet with the solution.

The strength of solution for effective results also varies within rather wide limits for each chemical, depending somewhat on the conditions of infection encountered by the fruit subsequent to treatment. Under less severe conditions of infection a weaker strength might prove as effective as would a greater strength of solution under more severe conditions of infection. In general, it may be stated that these chemicals are effective in aqueous solutions ranging in strength between ¾% and 5% by weight, but in some cases and under some conditions an effective strength may be less than ¾%, or strengths greater than 5% may be used without detriment to the fruit. However, tests made in the development of this invention have shown each of the specified chemicals to be effective at some strength within the range indicated.

The specific advance over other methods previously used consists in leaving on fresh fruit or vegetables as prepared for market a surface residue of the above mentioned inhibiting chemicals that will effectively check the development of rot fungi over an extended marketing period.

We claim:

A method for the prevention of decay of fresh citrous fruits consisting in the treatment of such fruits with an aqueous solution comprising lithium carbonate, at a temperature below 120° F.

Harry R. Fulton, John J. Bowman.

[fol. 713] PLAINTIFFS' EXHIBIT No. 57

Patented Nov. 10, 1925. 1,560,559

United States Patent Office

Harry R. Fulton and John J. Bowman, of Washington, District of Columbia

Process for Preservation of Fresh Fruits and Vegetables

No Drawing. Application Filed September 14, 1925. Serial No. 56,415

(Granted under the Act of March 3, 1883; 22 Stat. L. 625)

To all whom it may concern:

Be it known that we, Harry R. Fulton and John J. Bowman, citizens of the United States of America, and employees of the United States of America and employees of the United States Department of Agriculture, residing at Washington, D. C. (whose post-office address is care of Department of Agriculture, Washington, D. C.), have invented certain new and useful Processes for the Preservation of Fresh Fruits and Vegetables, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the United States, and its officers and employees, and by any person in the United States without the payment to us of any royalty thereon. We hereby dedicate the same to the free use of the Government and the people of the United States.

The object of this invention is to prevent the development of decay in citrus and other fruits and vegetables during the process of marketing, especially the prevention of the forms of decay of citrus fruits known as stem-end rot and blue-mold rot.

It has long been known that borax and baric acid have the property of preventing or retarding decay in fresh or raw fruits and vegetables. We have discovered that certain combinations of borax or of boric acid with certain other

chemicals that react with the borax or with the boric acid, forming new combinations, have superior preservative properties. We have found that such preparations are especially effective and useful for the control of various types of decay because of (1) their antiseptic or inhibitory action on the fungi causing the decay; (2) their ability to wet the surface and adhere thereto and penetrate to some extent into the tissues of the fruit where wounded; (3) their non-injurious effect on the fruit itself; (4) their non-toxic properties in the amounts used for persons consuming the fruit.

The combinations, all in aqueous solution, that have proved to be effective and useful for this purpose are: (a) 5% by weight of boric acid and 1.43% by weight of anhydrous sodium carbonate; (b) 5% by weight of borax and 0.43% by weight of sulphuric acid. The above stated proportions are for full strength of the chemicals; the equivalents of these are to be taken in case less than full strength of any ingredient is used in making the solution.

The strengths of solutions indicated are satisfactorily effective, as are also strengths based upon as low as 3% of borax or of boric acid or as high as 8% of borax or of boric acid, with the other ingredients in proper proportions.

Other mineral acids, in proper combining proportions, may be similarly used instead of sulphuric acid, such as hydrochloric acid, and other alkalis, such as sodium hydroxide and sodium bicarbonate, may be used instead of sodium carbonate.

In each of the above stated combinations a chemical reaction takes place by which the borax or the boric acid is practically all changed into combinations of the Na_2O and B_2O_3 radicals in proportions different from those in which they exist in borax. For instance in combinations (a) and (b) stated above the combining proportions and ingredients are such as to produce a ratio of 1 to 3 between the radicals N_2O and B_2O_3, respectively, according to the following chemical equations:

(a) $6H_3BO_3+Na_2CO_3=Na_2O3B_2O_3+CO_2+9H_2O.$

(b) $3Na_2B_4O_710H_2O+H_2SO_4=2Na_2O.3B_2O_3+Na_2SO_4+11H_2O..$

In ordinary borax this ratio is 1 to 2 as is shown by the formula $Na_2O.2B_2O_3$.

The method of treatment as applied to citrus fruits consists essentially in making up any one of the solutions in the proportions indicated, and in thoroughly wetting the surface of the fruit with the solution during the process of preparing it for market, the residue of the solution being allowed to dry on the fruit surface and to remain as a protection against subsequent development of decay. The treatment has been found effective at temperatures ranging from about 65° F. to about 120° F. At the higher range of temperature (between 105° F. and 120° F.) effectiveness is increased by soaking the fruit for about five minutes in a bath of the solution. If the treatment is given at lower tem- [fol. 714] peratures, it is sufficient to dip the fruit momentarily in the solution, or to spray the solution over the fruit by some suitable device. After being thoroughly wet with the solution the fruit should be dried in any convenient way, such as may be used ordinarily in citrus packing houses after simple washing of the fruit; and the other processes of brushing and polishing may be followed as is usually the practice with citrus fruits. Similar procedure would be followed with other fruits or vegetables; the object being to apply a thorough surface coating of the solution during the process of preparing the fruit for market, to allow it to dry so as to leave a slight and inconspicuous but effective residue, that will have a preservative effect during a prolonged marketing period.

The specific advance over other methods previously used consists in treating the fresh fruits and vegetables with a solution of borax or boric acid combined with mineral acids or with alkalis in such way as to produce highly effective combinations of Na_2O and B_2O_3, namely $Na_2O.3B_2O_3$, these being applied in such way as to leave a slight surface deposit that will effectively check the development of rot fungi over an extended marketing period.

We claim:—

1. An improved process for preparing fresh fruits and vegetables for market which comprises the application to the surface of such articles of an aqueous solution containing the sodium oxide radical and the boric acid radical in the proportion of one to three and of such a strength as to

effectively retard the growth and development of the organisms that cause stem-end rot, blue-mold rot, and other forms of decay.

2. An improved process for preparing fresh fruits and vegetables for market which comprises the application to the surface of articles of a solution containing approximately 5 parts by weight of borax and 0.43 parts by weight of sulphuric acid in 100 parts by weight of water, to effectively retard the growth or development of the organisms causing stem-end rot, blue-mold rot, or other forms of decay.

Harry R. Fulton, John J. Bowman.

[fol. 715] PLAINTIFFS' EXHIBIT No. 58

Patented Feb. 9, 1926. 1,571,938

United States Patent Office

Harry R. Fulton and John J. Bowman, of Washington, District of Columbia

Process for the Preservation of Fresh Fruits and Vegetables

No Drawing. Original Application Filed September 14, 1925, Serial No. 56,415. Divided and This Application Filed October 3, 1925. Serial No. 60,331

(Granted under the Act of March 3, 1883; 22 Stat. L. 625)

To all whom it may concern:

Be it known that we, Harry R. Fulton and John J. Bowman, citizens of the United States of America, and employees of the United States of America, and employees of the United States Department of Agriculture, residing at Washington, D. C., whose post-office address is care of Department of Agriculture, Washington, D. C., have invented certain new and useful Processes for the Preservation of Fresh Fruits and Vegetables, of which the following is a specification.

This application is a division of our application which bears Serial No. 56,415 and filing date September 14, 1925, on the same subject, and is made under the act of March 3, 1883, chapter 143 (22 Stat. 625) and the invention herein described and claimed may be used by the Government of the United States, and its officers and employees, and by any person in the United States without the payment to us of any royalty thereon. We hereby dedicate the same to the free use of the Government and the people of the United States.

The object of this invention is to prevent the development of decay in citrous and other fruits and vegetables during the process of marketing, especially the prevention of the forms of decay of citrous fruits known as stem-end rot and blue-mold rot.

It has long been known that borax and boric acid have the property of preventing or retarding decay in fresh or raw fruits and vegetables. We have discovered that certain combinations of borax or of boric acid with certain other chemicals that react with the borax or with the boric acid forming new combinations have superior preservative properties. We have found that such preparations are especially effective and useful for the control of various types of decay because of (1) their antiseptic or inhibitory action on the fungi causing the decay; (2) their ability to wet the surface and adhere thereto and penetrate to some extent into the tissues of the fruit where wounded; (3) their non-injurious effect on the fruit itself; and (4) their non-toxic properties in the amounts used for persons consuming the fruit.

The combinations, all in aqueous solution, that have proved to be effective and useful for this purpose are: (a) 5% by weight of borax and 1.39% by weight of anhydrous sodium carbonate; (b) 5% by weight of boric acid and 4.27% by weight of anhydrous sodium carbonate. The above stated proportions are for full strength of the chemicals; the equivalents of these are to be taken in case less than full strength of any ingredient is used in making the solution.

The strengths of solutions indicated are satisfactorily effective, as are also strengths based upon as low as 3% of borax or of boric acid or as high as 8% of borax or of boric acid, with the other ingredients in proper proportions.

Other alkalis, such as sodium hydroxide and sodium bicarbonate, may be used instead of sodium carbonate.

In each of the above stated combinations a chemical reaction takes place by which the borax or the boric acid is practically all changed into combinations of the Na_2O and B_2O_3 radicals in proportions different from those in which they exist in borax. For instance, in combinations (a) and (b) stated above the combining proportions and ingredients are such as to produce a ratio of 1 to 1, according to the following chemical equations:

(a) $Na_2B_4O_7.10H_2O+Na_2CO_3=$
$2Na_2O.B_2O_3+CO_2+10H_2O.$

(b) $2H_3BO_3+Na_2CO_3=$
$Na_2O.B_2O_3+CO_2+3H_2O.$

In ordinary borax this ratio is 1 to 2 as is shown by the formula $Na_2O.2B_2O_3$.

The method of treatment as applied to citrus fruits consists essentially in making up any one of the solutions in the proportions indicated and in thoroughly wetting the surface of the fruit with the solution during the process of preparing it for market, the residue of the solution being allowed to dry on the fruit surface and to remain as a protection against subsequent development of decay. The treatment has been found effective at temperatures ranging from about 65° F. to about 120° F. At the higher range of temperature (between 105° F. and 120° F.) effective- [fol. 716] ness is increased by soaking the fruit for about five minutes in a bath of the solution. If the treatment is given at lower temperatures, it is sufficient to dip the fruit momentarily in the solution, or to spray the solution over the fruit by some suitable device. After being thoroughly wet with the solution the fruit should be dried in any convenient way, such as may be used ordinarily in citrous packing houses after simple washing of the fruit; and the other processes of brushing and polishing may be followed as is usually the practice with citrous fruits. Similar procedure would be followed with other fruits and vegetables, the object being to apply a thorough surface coating of the solution during the process of preparing the fruit for market, to allow it to dry so as to leave a slight and inconspicuous but effective residue, that will have a preservative effect during a prolonged marketing period.

The specific advance over other methods previously used consists in treating the fresh fruits and vegetables with a solution of borax or boric acid combined with mineral acids or with alkalis in such way as to produce highly effective combinations of Na_2O and B_2O_3, namely $Na_2O.B_2O_3$, these being applied in such way as to leave a slight surface deposit that will effectively check the development of rot fungi over an extended marketing period.

We claim:—

1. An improved process for preparing fresh fruits and vegetables for market, which comprises the application to the surface of such articles of an aqueous solution containing the sodium oxide radical and the boric acid radical in equal proportions and of such a strength as to effectively retard the growth and development of the organisms that cause stem-end rot, blue-mold rot, and other forms of decay.

2. An improved process for preparing fresh fruits and vegetables for market which comprises the application to the surface of such articles of a solution containing approximately .5 parts by weight of borax and 1.39 parts by weight of anhydrous sodium carbonate in 100 parts by weight of water, to effectively retard the growth or development of the organisms causing stem-end rot, blue-mold rot, or other forms of decay.

Harry R. Fulton, John J. Bowman.

[fols. 717 & 718] PLAINTIFF'S EXHIBIT No. 59

Patented Sept. 7, 1926. 1,598,697

UNITED STATES PATENT OFFICE

William R. Barger and Lon A. Hawkins, of Washington, District of Columbia, Assignors, by Mesne Assignments, to the People of the United State

Process for the Treatment of Fruit for the Prevention of Decay

No Drawing. Application Filed January 25, 1926. Serial No. 83,705

(Granted under the Act of March 3, 1883; 22 Stat. L. 625).

This application is made under the act of March 3, 1883, Chapter 143 (22 Stat. 625) and the invention herein de-

scribed and claimed may be used by the Government of the United States or any of its officers or employees in the prosecution of work for the Government, or any person in the United States, without payment to us of any royalty thereon.

The object of the invention is the prevention of green mold decay caused by Penicillium digitatum Sacc. of citrus fruits.

This invention consists of a process of treating fruit, particularly citrus fruit, with a compound formed by dissolving borax and boric acid in water in the proportion approximating one part of borax to two parts of boric acid. This compound is readily soluble in cold water and will remain in solution in concentrations up to about 8 parts of the compound, to 100 parts of water at a temperature of 35° F. the solubility decreasing as the temperature is lowered. It is, however, much more soluble than either borax or boric acid alone, the solubility of borax being 6 parts per 100 in cold water, while boric acid is soluble up to about 4 parts in 100 parts cold water. There is then no danger of this compound settling or crystallizing out of the solution at any temperature above the freezing point of the solution when used in concent-ation much higher that that necessary to completely control the disease. It has been shown that a concentration of this compound of 3 parts in 100 parts of cold water prevents the growth of the common green mold of oranges and lemons caused by Penicillium digitatum Sacc. if the fruit infected with this fungus is soaked in the solution. An exposure of one minute in a solution of this compound in concentration of one part to 100 parts of water gives partial control of the disease but longer applications or higher concentrations are more effective.

The treatment with the above described solution is accomplished by immersing, submerging, or causing the fruit to travel through a receptacle or tank containing this solution in such a manner that the entire surface of the fruit is wet with the solution. The apparatus described by Barger, Hukill, and Hawkins in United States Patent Serial No. 1,559,733, dated Nov. 7, 1925, is used for this purpose.

We claim:

A process for the prevention of decay of fruits by green mold caused by Penicillium digitatum Sacc. consisting in

the treatment of such fruits with a compound of borax and boric acid in the proportion of approximately one part borax to two parts boric acid, dissolved in water at concentration of one to 8 parts of this compound to 100 parts of water.

William R. Barger, Lon A. Hawkins.

[fol. 719] PLAINTIFF'S EXHIBIT No. 60

Office of California Fruit Growers Exchange, Los Angeles, California

December 19, 1924.

To all shippers.

GENTLEMEN: At our Directors' meeting on December 10th, a representative of the United States Department of Agriculture presented the results of experiments that have been conducted by the Department in the treatment of citrus fruit for control of decay from blue and green molds.

It was brought out in the discussion that borax or compounds of borax have been used commercially as an antiseptic and as a preservative for many years, and that the Department has used borax and other chemicals with more or less success in controlling fruit diseases.

In the work for controlling blue and green molds in citrus fruits a number of solutions for soaking the fruit have been tested out; including Potassium, alum, salt, zinc chloride and borax. The latter seemed to give the best results although partial control was obtained with some of the other materials. Special attention was given to developing the best method of applying borax and the work largely confined to determining the concentration of borax, time of application, and temperature of solution which gave the best results most economically.

Experiments with ripe oranges injured in the laboratory, inoculated with blue and green mold spores, treated with borax solution and then held for seven weeks showed that mold could be controlled by this treatment. The results of these experiments are now in press.

The Exchange Field Department, which has cooperated with the Department in further work embracing experi-

ments under commercial conditions, also reported on these experiments as follows:

[fol. 720] "This work was carried on at the Azusa Citrus Association packing house. The fruit was injured by clipping away a piece of skin and a mixture of blue and green mold spores was applied to the injury. The following day the fruit was run through the borax solution and over the regular packing house machinery. After being wrapped and packed, the fruit was stored at a constant temperature and high humidity and inspected each week for six weeks.

The decay of the fruit not treated with borax shows that optimum conditions for rotting were present during storage.

Many experiments covering different strengths of borax, varied time of application and different temperatures of solution were run. The percentage of decay in comparable lots of fruit not treated and treated with borax solution is given below. All of this fruit was injured and inoculated; so there was a potential 100% decay, if not treated.

Treated for 6 Minutes at 110°

Soaked in Water, total Blue and Green Mold DK 1 week 99.3%—After 6 weeks 99.3%.

Soaked in 2½% Borax solution, total Blue and Green Mold DK 1 week 13.4%—After 6 weeks 30.7%.

Soaked in 4% Borax, solution, total Blue and Green Mold DK 1 week 1.6%—After 6 weeks 12.2%.

Soaked in 8% Borax solution, total Blue and Green Mold DK 1 week 1.3%—After 6 weeks 7.3%.

Soaked in 9% Borax solution, total Blue and Green Mold DK 0.6%—After 6 weeks 2.8%.

Fruit Treated with 4% Borax Solution for 6 Minutes

At 69° F.; after 3 weeks storage 9.8% Decay, after 6 weeks storage 24.6% Decay.

At 110° F.; after 3 weeks storage 4.2% Decay, after 6 weeks storage 12.2% Decay.

Fruit Treated with 4% Borax Solution at 110° F.

For 4 minutes; after 3 weeks storage 5.3% decay, after 6 weeks storage 19.4% decay.

[fol. 721] For 6 minutes; after 3 weeks storage 4.2% decay, after 6 week storage 12.2% decay.

The above data show that 110° solution is more effective in controlling blue and green mold than cold solution and that decay is decreased as the percentages of borax and time of application are increased.

Seven per cent borax solution seems to be strong enough to give good control of mold in commercially run fruit, for 6% was as strong as was used for the commercial applications of Azusa and good results were obtained. The time of application for this commercially run fruit was about five minutes, and since space required for a tank which will allow a longer application is seldom available in a packing house, this will be the practical limit. Where it is possible to get a six-minute application it would probably be advisable.

Several experimental commercial shipments were made from Azusa. Fruit from the same grove was used, part of which was treated with borax solution and part not treated. The first car went to Pittsburgh; was inspected nine days after it rolled: Eight boxes not treated had 2.9% decay, nine boxes treated had 0.4% decay. A car inspected at Oklahoma City after seven days on the road: five boxes not treated had 0.6% decay, five boxes treated no decay. A car to Hartford inspected after 21 days: six boxes not treated had 3.3% decay, six boxes treated 0.9% decay. A car of sweated fruit at Minneapolis after 19 days—the last 10 days the fruit had been held in the warehouse—three boxes not treated had 11.4% decay, three boxes treated 2.6% decay. All of the above were shipped under refrigeration. One ventilated shipment to Albany after eleven days on the road: three boxes not treated 0.6% decay, six boxes treated 0.2% decay. Three boxes of each lot from this car were expressed to Washington where they were held and inspected every four days. The inspection after 21 days at Washington, or 33 days after it left Azusa, showed the non-treated fruit had 18.7% decay and the treated fruit 4.0% decay.

[fol. 722] For the commercial installation at Azusa Citrus Association, an old separator tank was equipped with submerging paddles and baffle boards so as to submerge the fruit. The fruit was then conveyed to the association's

regular washing tank, which was equipped with a baffle board to increase the length of time of the fruit in this tank and also to submerge it. The solution in this tank consisting of a 2.5% to 2.8% concentration was sprayed on the brushes. In the special tank different concentrations were used. At the commencement a 2.5% solution was used which was increased to 4%, 5% and a 6% concentration was used the last week.

The heater for this special tank was not of sufficient capacity, so that at no time did the temperature in this tank get above 95° and seldom above 90° and it would only get up to this temperature late in the morning or early in the afternoon, so most of the fruit was treated between 80° and 90°.

The Azusa Citrus Association did not pack any fruit between July 28th and August 28th, and the following tabulation covers all straight cars of treated and not treated fruit shipped after August 28th as taken from the sales sheets of the Exchange. Cars with less than 3% decay are not included with cars under commercial decay. No fruit was treated before September 30th, but after this date practically all the fruit was treated.

Decay in Commercial Shipments

	Not treated		Treated	
	Cars sold	Commercial DK	Cars sold	Commercial DK.
Sept...	12	1 car with 3% DK.....	0	0
Oct....	24	1 car with 3% DK.....	10	0
		1 car with 4 & 5% DK..		
		3 cars with 5% DK.....		
		1 car with 6% DK.....		
		1 car with 10% DK.....		
Nov...	1	0	20	1 car with 3% DK.
	37	8	30	1

In addition to the above there were 30 cars shipped containing most treated fruit but also some not treated for [fol. 723] test purposes, and there was no commercial decay reported in the treated fruit in these cars.

This shows good commercial control, especially when it is taken into consideration that this fruit was treated at a lower temperature and lower concentration than has been found desirable in the holding tests.

The one car of treated fruit showing 3% decay was treated on a Saturday and a Monday morning when the

temperature of the solution was quite low, which may account for the decay in this car; however, it is impossible to tell what the decay would have been in this car if the fruit had not been treated.

The use of this process or any other process at the present time will not eliminate all decay; so careful handling of the fruit in all the operations should not be disregarded. This applies especially to injuries after treatment and especially long-stem punctures as injuries received after treatment may become inoculated and decay develop.

The records from the numerous test lots show that where decay developed in a lot of treated fruit the fruit from this same lot and not treated developed from three to five or six times as much decay.

Equipment Necessary

In addition to soaking tank and brushes already in packing house, it will be necessary to have another tank between the brushes and the driver, this tank to be 4 feet by 20 feet for a 3 car a day unit, this tank to be equipped with submerging paddles and baffle boards. The regular tank also to be equipped with submerging paddle and baffle board. Both tanks to be heated to 110° and charged with a 7% borax solution. A light water spray to be used on the brushes between the two tanks. This spray will take the dirt off the oranges and keep it out of the second tank and it will be possible to run the first tank for a long time before changing as any dirt carried from the first tank will be washed off in the brushes. The second tank will probably [fol. 724] not have to be changed before two or three weeks as it will not be getting any dirty fruit. After the second tank a light water spray should be used to remove the excess borax."

Our Field Department will be glad to give further details of the experiments and equipment needed to any shippers who are interested in the matter.

Yours truly, E. G. Dezell, General Manager.

EGD:CPM.

No. 69.

PLAINTIFFS' EXHIBIT No. 61.

Office of California Fruit Growers Exchange, Los Angles, Calif.

June 20, 1924.

To all shippers.

GENTLEMEN: We enclose herewith report covering investigations and experiments conducted by our field department with the products and methods known as Brogdite and Brogdex. The tests with Brogdite were conducted to determine its effectiveness in controlling blue mold decay, and with Brogdex its value in retarding shrinkage and preserving the appearance of oranges, particularly when shipped or handled under ventilation.

Until very recently, the only practical method of controlling blue mold decay has been by preventing mechanical injuries to the fruit through the most careful handling in both field and packing houses. Efforts have for years been made by scientists and others to find something that would kill the blue mold fungus and spores but which would not injure the fruit. While a number of substances have been found that will kill both the blue fungus and spores, they [fol. 725] either injure the fruit, are too expensive or impractical of application, or are dangerous because of their poisonous properties.

The methods of procedure in making these tests were to positively injure each fruit and inoculate the injury with blue mold. This method of testing was about as severe as could be devised, and was intended to be.

The report of our field department gives the results in detail for the tests made over a period of several months, and merits your very close study as it indicates that blue mold can be controlled with Brogdite in much the same way as brown rot is controlled with blue stone or hot water. In general, the lots treated in the approved manner and strength of solution developed little decay during a period of 40 or more days following treatment. Untreated fruit similarly injured and inoculated held under similar conditions developed very heavy decay.

In addition to the experiments conducted by the field department, the Walnut Fruit Growers Association has used these processes on a commercial scale on all their shipments

this season,—the shipments being all forwarded under ventilation. Inspection reports covering 86 cars have been received to date. Seventy-eight of these were navels, the remainder seedlings, miscellaneous and valencias. The navels were shipped continously over a period from January 8th to April 17th. Decay in excess of 3 per cent was reported in only three of these cars at the last inspection, one showing 4 per cent., one 5 per cent. and one 6 per cent. The reports do not indicate the kind of decay. This association is continuing the use of the processes on the balance of their valencias, shipping them all under ventilation.

After heavy decay commenced to show up with our later shipments of navels, some of this very ripe and tender fruit was treated to see if the process would control such decay. This was commercially handled fruit. In one lot, after 21 days the checks developed 21.6 per cent blue mold decay and treated fruit 6.5 per cent blue mold decay. In another lot, the checks developed 25 per cent blue mold decay and the treated fruit 8.3 per cent 15 days after packing. No experi- [fol. 726] ments were made to ascertain if such fruit would hold up better under refrigeration and further experiments will be necessary to determine whether such fruit can be as successfully handled to market with this treatment as under refrigeration. The same question arises concerning valencias which have been under heat for long periods for coloring. From previous experiments, fruit so treated is weakened and develops decay from other than mechanical injury causes.

However, the great bulk of our blue mold decay is caused by mechanical injuries to the fruit before it is packed and these experiments indicate that Brogdite properly applied to fruit mechanically injured will control the development of blue mold decay from that cause. Some of these experiments showed that when blue mold had developed to spots as large as a dime the treatment stopped its further growth. It will not prevent the development of blue mold decay where the fruit has been mechanically injured in some manner after treatment.

In general, the Brogdexed fruit developed no more marked spotting than the untreated lots, except for the frosted fruit lot at Strathmore, one of the tests with late ripe navels and

a small experimental shipment to England. The Strathmore fruit was Brogdexed by hand and probably received a very heavy coating. The lot of ripe navels was also Brogdexed heavier than most of the experimental lots or the commercial shipments. Experience to date seems to indicate that too heavy an application of Brogdex may cause marked spotting. The amount of Brogdex now being applied apparently does not induce excessive spotting as only sufficient Brogdex is put on to preserve the fresh appearance of the oranges for from five to six weeks.

We have been negotiating with the Brogdex Company for the use of their processes by our Exchange shippers. Their final proposition is substantially as follows:

[fol. 727] The shipper contracts to pay a license fee or royalty on all fruit handled above the grade of culls during the life of the contract, this on the conclusive presumption that one or both processes have been applied to all fruit except culls.

The contract will be continuous but is subject to cancellation by the shipper at the end of any season.

The equipment is to be installed by the Brogdex Company, but is to be paid for by the shipper at actual cost; one-half to be paid on signing the contract and balance when installation is completed.

It is estimated that this equipment will cost for

3-car capacity, 2 runway, equipment $3,000.

6-car capacity, 4 runway, equipment $4,500.

9-car capacity, 6 runway, equipment $5,500.

The equipment consists principally of a specially made and heated soaking tank to contain the Brogdite, brushes for cleaning and further application of Brogdite, sprayers and brushes for the application of Brogdex, and such conveyors, belts and equipment as is necessary for the proper conveyance of the fruit. This takes the place of present washing equipment, the Brogdite being a cleansing agent also.

The contract also provides that the shipper pay the actual cost of the Brogdite-Brogdex materials to be supplied by the Brogdex Company.

The shipper is to operate and care for the equipment at his expense, to use the equipment only in the application of the Brogdex and Brogdite processes, and to use the ma-

terials furnished in accordance with instructions furnished by the Brogdex Company.

The Brogdex Company agrees to keep accurate record of all costs of installation of equipment, and the cost of all materials furnished the shipper. The shipper agrees to keep accurate records of all oranges, except culls, run through its packing house and to furnish monthly a certified statement of the number of packed boxes run through the house the preceding month.

[fol. 728] The records of the Brogdex Company and the shipper, above referred to, to be open to inspection by both parties.

The royalty or license fee to be paid the Brogdex Company by Exchange houses is 4¾ cents per box with the proviso that this will be adjusted to 4½ cents if the Brogdex Company received royalty on from 5,000,001 to 10,000,000 boxes from California citrus shipments during any one year; 4¼ cents if from 10,000,001 to 15,000,000 boxes are treated; 4 cents if from 15,000,001 to 20,000,000 are treated; and 3¾ cents if over 20,000,000 boxes.

The estimate of cost, including interest and depreciation on cost of equipment and installation, supervision and cost of material is 1½ cents per box, which with a royalty of 4¾ cents would make the total cost per box 6¼ cents. The 1½ cent estimate is made up of

Cost of Brogdite material	4/10 of a cent.
Cost of Brogdex material	3/10 of a cent.
Labor to operate and care for	3/10 of a cent.
Extra machinery depreciation	1/10 of a cent.
Incidentals	4/10 of a cent.

It may not be advisable for all shippers to use both Brogdite and Brogdex processes throughout the season as Brogdex sets the color of the fruit and should not be applied until the fruit is of satisfactory color. The royalty is to be paid, however, on all fruit handled through the house, except culls.

The earlier navel shipments go out under ventilation during the cooler part of the season and probably would not be greatly benefited by the application of Brogdex. The advantage in the use of Brogdex would come later in the sea-

son when by the application of both Brogdite and Brogdex oranges may be shipped under ventilation instead of refrigeration. Ice is utilized at that season of the year primarily to retard blue mold decay but also to maintain the fresh appearance of the fruit.

Brogdite could advantageously be used on all shipments as, even though shipments arrive in practically sound condi- [fol. 729] tion, many develop decay later when held under conditions favorable to the development of blue mold in the fruit mechanically injured.

Test No. 13 shown in the report shows that the Brogdite-Brogdex treated fruit held under ventilation not only remained practically sound during the first period of 21 days but remained so for more than a month later. Refrigeration only retarded the decay in the untreated fruit during the period it was under refrigeration, blue mold developing very rapidly in the mechanically injured fruit after removal to warmer temperatures.

The advisability of the adoption of these processes on the terms outlined must, of course, be determined by each shipper. In our consideration of the matter several points have been discussed, viz.:

Some shippers now move all or a large part of their shipments under refrigeration and could figure a direct saving if refrigeration was not used. Others ship all or a considerable proportion under ventilation at present; their advantage would come from saving the losses in allowances at time of sale and the indirect losses occasioned by fruit decaying in the hands of the trade.

Ventilated shipments gather more dust and cinders on the packages than refrigerated shipments. However, our lemons practically all move under ventilation throughout the year without complaint.

The trade may have some prejudice against ventilated fruit during the usual icing season but this would be overcome if their experience demonstrates that the fruit will hold up.

The trade may hold fruit for speculation more than they do now if the hazard is reduced; however, a light coating of Brogdex will not retain the appearance for an unreasonable period and the flavor of the fruit would deteriorate.

On the other hand, a reduced decay hazard would be helpful in wider distribution.

The Brodex treatment will allow loss shrinkage of the fruit in ventilated shipments and maintain a better appear- [fol. 730] ing pack. The Brogdex fruit is slightly harder to peel than fruit shipped under present methods, being somewhat similar to peeling an orange taken right from the tree.

The possibility of something else being discovered to accomplish the same results at lower cost, necessitating the scrapping of the Brogdite-Brogdex equipment before entirely depreciated.

We have endeavored in the report and this circular to give you the principal facts concerning this new development, and to those who are interested we will be glad to furnish any further information desired if it is obtainable from our records or from the Brogdex Company.

Experiments are being made on lemons, but they are not complete and at this time the processes are being offered only on oranges.

Yours truly, E. G. Dezell, General Manager.

EGD:E.

46.

Report of Brogdite and Brogdex Tests Made by the Field Department of the California Fruit Growers Exchange, Navel Orange Season, 1923-24

During the summer and fall of 1923, the Brogdex Company of California made demonstrations at various packing houses and also at their plant at Palms with a substance called Brogdite, which it was claimed would either kill or prevent the development of blue mold. Their demonstrations showed quite conclusively that they had something worth investigating. The field department was requested to make a thorough investigation of the Brogdite process, and arrangements were made with the Brogdex Company to make some preliminary tests in Tulare County. The Brogdex Company brought up their experimental equipment consisting of a small rectangular tank, drying trays and a steam boiler to be used for heating the water. The [fol. 731] equipment was set up in the deciduous fruit pack-

ing house of the Strathmore Fresh Fruit Growers Association at Strathmore.

The Brogdex Company had done very little experimenting to determine what strength of Brogdite was most efficient. The strength then being used left on the fruit a powdery deposit produced by crystallization of the liquid used. One of the main purposes of these tests was to determine how weak a solution would be efficient and whether rinsing the fruit with plain water afterwards would lessen the efficiency of the Brogdite, thus tests No. 1 to 7 were put up on an experimental basis and are not comparable to Tests 9 to 13, which were put up under commercial conditions at the Walnut Fruit Growers Association.

In the tests at Strathmore, the fruit (all sweated) was injured by slicing a piece of skin off the orange near the stem end with a knife and then inoculating it by rubbing blue mold spores in the cut. Some of this fruit was then treated the same day as injured and inoculated, other lots 24, 48 and 72 hours later. The lots that were not treated the same day as injured and inoculated were stacked in a small storage room and heavy wrapping paper wrapped around the stack so as to obtain as ideal conditions as possible under the circumstances for the development of blue mold. The reason for injuring and inoculating some of the lots one day to three days prior to treatment was to determine if the Brogdite would stop the development of the mold if the spores had germinated.

Test No. 2

Navel Oranges—Tulare County

Nov. 17 to Jan. 15—59 Days

Injured and Blue-mold Inoculated

1. Checks—Not Brogdited	66.6%	Blue	Mold	Decay.
2. Brogdited ⅛ lb. per gallon	28.9%	"	"	"
3. Brogdited ¼ lb. to ½ lb. per Gallon	1.5%	"	"	"
4. Brogdited ¾ lb. to 1½ lbs. per gallon and Brogdexed	1.0%	"	"	"

[fol. 732] Injured, Then Brogdited, Then Inoculated

Checks—Not Brogdited	59.6%	Blue Mold Decay.
Brogdited same day as injured and then inoculated	7.0%	" " "
Brogdited 24 hours after injury and then inoculated	2.0%	" " "
Brogdited 24 hours after injury and then inoculated 24 hours after Brogdited	0.0%	" " "

Test No. 2, Navel oranges, Tulare County, was tabulated separately from Tests No. 4 and 5 because this fruit was not as mature as the fruit used in the latter tests. This, coupled with the low humidity and low temperatures in this section at this time, seemed to retard the decay and even in the check lots injured and inoculated which were not Brogdited, there was only 66.6 per cent decay at the end of a 59 day period. Different strengths of Brogdite solutions were used and it was found that one-eighth pound per gallon was too weak and would not stop the decay sufficiently as there was 28.9 per cent decay in the fruit treated with this strength solution. With the stronger strengths ranging from one-fourth to one and one-half pounds to the gallon, there was practically no decay.

The fruits under the last group in the above table were injured by cutting a slice off near the stem end and then Brogditing one lot of oranges the same day and rubbing the blue mold spores on the injury as soon as the fruit was dry after Brogditing. Another lot was Brogdited 24 hours after injury and then inoculated with blue mold spores as soon as the fruit was dry. A third lot was Brogdited 24 hours after injury and inoculated with blue mold 24 hours after Brogditing. These fruits were not Brogdited again after inoculation with blue mold.

The results show that the Brogdite solution is also effective in preventing blue mold starting in injuries occurring prior to treatment even if these injuries became inoculated with blue mold after treatment. This does not mean, [fol. 733] however, that the solution is affective in preventing the development of blue mold in injuries occurring after Brogditing.

Tests No. 4 and 5

Effect of Rinsing

Navel Oranges—Tulare County

Test 4—Dec. 3 to Jan. 15—42 days

Test 5—Dec. 4 to Jan. 15—41 days

Oranges Immersed in Brogdite Solution 2 Minutes

Injured and Inoculated with Blue Mold

			Brogdited (8 oz. to 12 oz.)	
	Not Brogdited Blue-mold decay	Brogdited (4 oz.-8 oz.), not rinsed Blue-mold decay	Rinsed with plain water immediately after removal from tank Blue-mold decay	Rinsed with plain water 2½ minutes after removal from tank Blue-mold decay
Test 4	98.9%	5.0%	23.3%	.....
Test 5	95.0%	4.4%	10.4%	4.0%
Average	95.9%	4.6%	16.8%	.....

Injured, Then Brogdited, Then Inoculated

	Checks not Brogdited Blue-mold decay	Brogdited (6 oz. per gal.) Brogdited 24 hrs. after injury dried and then inoculated Blue-mold decay
Test 4	92.6%	1.2%
Test 5	97.5%	4.4%
Average	95.0%	2.9%

The fruit used in the above two tests was more mature than the fruit used in Test No. 2 and the checks injured and inoculated showed 95.9 per cent decay, while in Test No. 2 they only showed 66.6 per cent decay, although the latter were inoculated and handled in the same manner as the former.

In Test No. 2 some "powder" trouble was encountered, especially with the fruit treated with the stronger solu-

tions. The water would evaporate from the fruit and leave some of the Brogdite on the fruit in the form of a powder. Commercially, this would necessitate installing brushes to remove this powder after the fruit had gone through the [fol. 734] drier. To overcome this powder trouble, the fruit was subjected to a sprinkle of fresh water immediately after taking it out of the Brogdite solution. This fresh water sprinkling eliminated the powder trouble but it also cut down on the efficiency of the Brogdite as will be seen in the above table. In the lots treated in Brogdite solutions ranging instrength from 4 ounces to 8 ounces to the gallon and the fruit not rinsed with fresh water afterwards, there was only 4.6 per cent decay, while the lots treated in stronger strength Brogdite ranging from 8 ounces to 12 ounces per gallon and rinsed with plain water immediately afterwards showed 16.8 per cent decay.

In Test No. 5, the rinsing idea was carried one step farther than in the preceding tests. One lot was rinsed with fresh water immediately after a two-minute immersion in Brogdite and another lot was rinsed 2½ minutes after a two-minute immersion in Brogdite of the same strength as the former lots. As will be seen in the above table by comparing the figures for Test No. 5 the fruit treated in Brogdite solution of only 4 ounces and 6 ounces to the gallon and not rinsed showed only 4.4 per cent decay, the fruit treated in stronger solutions and rinsed at once showed 10.4 per cent decay while the lot rinsed 2½ minutes after removal showed only 4.0 per cent decay, or about the same as the fruit treated in the weaker solutions and not rinsed.

The above results indicate that the time factor was a very important consideration and in the commercial installation at Walnut the equipment was so arranged that the fruit was in the tank, elevator, brushes and time-killer for 7 minutes before it was rinsed with plain water. Later the time was increased so that the fruit was on the Brogdite equipment from 8½ to 10 minutes before being sprinkled with plain water. The oranges in Tests No. 9 to 13 were left in the Brogdite soaking tank from 3 to 4 minutes and were not sprinkled with fresh water until four to five minutes after the fruit came out of the soaking tank. [fol. 735] The foregoing tests were all put up on an experimental basis in Tulare County, while the subsequent tests were put up at the Walnut Fruit Growers Associa-

tion with their commercial Brogdite and Brogdex equipment. In the former tests it was mostly a matter of finding out what to do and what not to do, whereas, the tests at Walnut were put up on a commercial basis.

Tests No. 9 to 12

Test No. 9—Navel Oranges from Walnut, Cal., Jan. 23-Feb. 29—37 days since Brogdited

Test No. 10—Navel Oranges from Gold Buckle Ass'n., Redlands, Cal., Feb. 1-Mar. 14—42 days since Brogdited

Test No. 11—Navel Oranges from Gold Buckle Ass'n., Redlands, Cal., Feb. 1-Mar. 14—42 days since Brogdited

Test No. 12—Navel Oranges from Whittier Citrus Ass'n., Whittier, Cal., Feb. 2-Mar. 14—41 days since Brogdited.

Commercially Sound

	Checks not Brogdited, blue-mold decay	Brogdited only blue-mold decay	Brogdited & Brogdexed, blue-mold decay
Test 9	5.3%	1.3%	4.0%
" 10	10.7%	1.3%	2.7%
" 11	4.0%	0.0%	0.0%
" 12	16.0%	5.3%	4.0%
Average	9.0%	2.0%	2.9%

Clipper Cuts and Inoculated with Blue Mold

	Checks not Brogdited, blue-mold decay	Brogdited only blue-mold decay	Brogdited & Brogdexed, blue-mold decay
Test 9	99.3%	21.0%	15.7%
" 10	92.0%	22.7%	17.3%
" 12	88.0%	10.7%	10.7%
Average	96.2%	19.6%	15.1%

Clipper Cut First, Then Brogdited, Then Inoculated

(Part of Test 9 Only)

Checks—Not Brogdited	98.6%	Blue Mold Decay
Brogdited same day as injured then inoculated when dry	28.0%	" " "
Brogdited and Brogdexed same day as injured and then inoculated when dry	24.0%	" " "

[fol. 736] The oranges used in these tests were injured and inoculated by making a clipper cut at the stem end and then rubbing blue mold spores into the cut. In Test No. 9, one lot of the injured and inoculated fruit was Brogdited and another lot "Brogdited-Brogdexed" the same day as injured and inoculated, two other lots Brogdited and "Brogdited-Brogdexed", respectively, 24 hours after injury and inoculation and two other lots "Brogdited-Brogdexed" 72 hours after injury and inoculation. In Tests 10 and 12, one lot of the injured and inoculated fruit was Brogdited and another lot "Brogdited-Brogdexed" 48 hours after injury and inoculation. Between the time of inoculation and Brogditing this fruit was stored loose in field boxes and heavy paper wrapped around the boxes. The check lots were hauled in an automobile to the Pomona Fruit Growers Exchange and run through their washer and drier. After treatment, the oranges were packed and the boxes stacked in the basement two layers high and heavy wrapping paper tacked around the stack so as to put all the boxes under as nearly identical conditions as possible. The above table shows the average amount of decay.

Test No. 13

A lot each of commercially sound, clipper cut only, clipper cut and inoculated oranges were commercially washed and dried at the Pomona Fruit Growers Exchange and another lot of each "Brogdited-Brogdexed" at the Walnut Fruit Growers Association. Half of each of these lots after packing was placed in a vault in the basement of the packing house into which ice had been placed and more ice added as needed to get refrigerator car conditions and the other half of each lot placed in the gas generator house near the packing house to get ventilator car conditions. The fruit was held under these conditions for three weeks before any inspection was made and after this inspection the fruit was repacked and held on the floor of the packing house and three more inspections made, the last one being [fol. 737] made 67 days after the fruit had been "Brogdited-Brogdexed." The following table shows the average decay at the first and last inspections.

Test No. 13

Navel Oranges from Walnut, Cal.

Feb. 15 to Apr. 22, 1924

Inspection 3 Weeks After Brogditing and Brogdexing at Time of Removal from Iced Vault and Ventilating House

	Ventilated fruit		Refrigerated fruit	
	Checks not Brogdited, blue-mold decay	Brogdited & Brogdexed, blue-mold decay	Checks not Brogdited, blue-mold decay	Brogdited & Brogdexed, blue-mold decay
Commercially Sound....	0.0%	0.0%	0.0%	0.0%
Clipper Cut only.....	17.3%	0.0%	2.0%	0.0%
Clipper Cut and Inoculated	94.7%	1.3%	54.7%	0.0%

Inspection 67 Days After Brogditing and Brogdexing, or 46 Days After Removal from Iced Vault and Ventilation House

	Ventilated fruit		Refrigerated fruit	
	Checks not Brogdited, blue-mold decay	Brogdited & Brogdexed, blue-mold decay	Checks not Brogdited, blue-mold decay	Brogdited & Brogdexed, blue-mold decay
Commercially Sound....	3.2%	0.0%	0.0%	1.3%
Clipper Cut Only.....	25.3%	0.0%	33.3%	0.7%
Clipper Cut and Inoculated	98.7%	5.3%	92.0%	9.3%

Commercial Pack

Inspection 67 Days After Brogditing and Brogdexing

There was no check lot in this because the boxes used were taken from the press at the Walnut Fruit Growers Association and this fruit was not from the same lot as the rest of the fruit in Test No. 13.

Brogdited and Brogdexed

Ventilation	0.5%	Blue Mold Decay
Refrigeration	0.0%	" " "
Average	0.2%	" " "

[fol. 738] Appearance at Time of Removal from Iced Vault and Ventilating-house

At the time of removal from refrigeration and ventilation, there was practically no difference in appearance and firmness between the Brogdexed lot held under refrigeration, the Brogdexed lot held under ventilation and the check lot held under refrigeration. The check lot held under ventilation was not quite as firm as the other lots, but was firm enough from the commercial standpoint.

Appearance 3 Weeks After Removal from Iced Vault and Ventilating-house

The inspection 3 weeks after the fruit had been removed from the refrigeration and ventilation rooms showed that there was very little or practically no difference in firmness and appearance between the Brogdexed lot held in the iced vault and the one held under ventilation. The check lot held under refrigeration was not quite as firm as the Brogdexed lot, but it was firm enough from a commercial standpoint and of good commercial appearance. The check lot held under ventilation was shrunken and shriveled considerably more than the lot held under refrigeration. The two Brogdexed lots had a slightly glossier appearance and were firmer than the check lot held in the iced vault, but the latter had a slightly deeper orange color.

Appearance 46 Days After Removal from Iced Vault and Ventilating-house

An inspection of these oranges on April 22, which was 67 days after the fruit was treated, showed a difference in firmness between the Brogdexed and Non-Brogdexed lots in favor of the former.

The Brogdexed lots are slightly harder to peel than the Non-Brogdexed lots, the white portion clinging to the edible portion of the orange and not separating away as easily as with the Non-Brogdexed lots, being somewhat similar to trying to peel an orange taken right from the tree, especially in the early stages of maturity.

[fol. 739] The Brogdexed oranges had a slightly sweeter flavor than the Non-Brogdexed, the latter tasting more acid.

However, the difference in the flavor is probably not enough so that the average consumer would object to it or notice the difference.

Prevention of Drying Out After Freezing

After the freeze in Tulare County, the first part of December, 1923, it was thought desirable to Brogdex some oranges that had been frosted and hold them to see if this Brogdexing would prevent the oranges from drying out. The Brogdexing was done with hand brushes. The following table shows the results of this test.

Tests No. 6 and 7

Frozen Oranges Brogdexed to Prevent Evaporation

Fruit Packed December 15 at Strathmore, California

	Inspection Jan 15		Inspection Feb 15	
	Slightly open	Slight	Bad	Total
Checks	36.7%	24.0%	26.0%	50.0%
Brogdexed	33.3%	25.0%	22.0%	47.0%

(Oranges classed as bad if affected in 3 sections or more.)

As will be seen in the above table, there was not enough difference between the checks not Brogdexed and the Brogdexed lots to show that the Brogdexing stopped the evaporation.

Spotting

About two years ago when the Brogdex Company commenced operations in California, they were putting a very heavy coating of wax on the oranges and more or less pitting or spotting was noticed at that time. Their method of applying the wax or Brogdex was rather crude at that time but now with their electrically heated atomizer for applying the Brogdex they can control quite accurately the amount of Brogdex applied and they are not applying a very much lighter coating than they did formerly.

Tests 9 to 12, Inclusive

	Feb. 29	Feb. 29
Checks—Not Brogdited	8.7% spotted	8.7% spotted
Brogdited	4.7% "	6.3% "
Brogdited and Brogdexed	12.3% "	12.0% "

[fol. 740] To determine whether the Brogdexing would tend to cause more pitting or spotting, three lots of fruit were obtained from districts where they have more or less spotting trouble and these were divided into 3 lots,—one lot being run through the commercial washer and drier at the Pomona Fruit Growers Exchange, the second lot through the Brogdite equipment at Walnut Fruit Growers Association but removed before going through the Brogdexing machine, and the third lot run through the complete Brogdite and Brogdex equipment. The above table shows the amount of spotting in these lots. There was somewhat more spotting in the Brogdexed lots than the checks, however, the spotting in the above lots was very slight and with the exception of about half a dozen oranges, they would not be classed in a commercial sense as being spotted.

Spotting in Test No. 7

Frosted Fruit from Strathmore, California

Treated and Packed December 15, 1923

Inspection Feb. 15, 1924

Checks—Not Treated	2.2% spotted
Brogdited and Brogdexed 10-90	30.2% "
Brogdited and Brogdexed 25-75	30.4% "

The fruit in the above table was put up to determine if the Brogdexing would stop the drying out of frozen fruit. The Brogdexing was done by using hand brushes and it may be that it was given too heavy a coating. No spotting was noticed while cutting some of this fruit for frost inspection on January 15, which was one month after it was packed, but at the time of the next inspection, which was a month later, there was a decided spotting on this fruit as will be noticed in the above table. At the time of the first inspec-

tion for frost, no inspection was made as to spotting but probably if the spotting had been as noticeable as at the last inspection, it would have been noticed and a special [fol. 741] inspection for spotting made at that time. The spotting on the oranges in the above lot ranged from two or three spots to covering nearly half of the orange. The spots really were numerous pits and had not turned brown in color like the ordinary brown spot but the appearance of most of them was such that they would be discounted commercially. It would appear that this spotting is tied up more or less with the thickness of Brogdex coating applied and if this coating is not too heavy no trouble will result.

Loss of Weight in Test No. 13, Walnut, Cal.

Oranges Held in Iced Vault for 3 Weeks

Average per box loss Brogdexed Lots (3 boxes)	6/16 pound
Average per box loss Checks (½ box computed on box basis)	8/16 "

Oranges Held under Ventilation for 3 Weeks

Average per box loss Brogdexed Lots (3 boxes)	2 3/16 pounds
Average per box loss Checks (½ box computed on box basis)	3⅞ "

On account of the decay in the inoculated check lots, the weights of these would not be comparable to the sound fruit, so these weights were not taken. Weights were taken of the commercially sound lots in the other tests in Southern California also, but it was found that the scales used were not accurate so that these weights are not given.

Powder Trouble from Brogdite

Because of the heavy concentration of Brogdite used, it crystallizes very readily when the water cools and also any of the solution splashing out of the tank leaves a white powder upon drying. However, with their plant at Walnut they have taken care of this satisfactorily with splash boards.

Oiliness of Brogdexed Fruit

The solvent used in the Brogdex to dissolve the wax is quite volatile and the oranges are not as "oily" when they [fol. 742] reach the bins as they were under their old method of applying Brogdex. However, some of this oil and wax sticks to the rollers on the sizers, which has a tendency to collect dust and necessitates cleaning these rollers periodically—maybe every week or two.

At present they are trying out a felt buffer on the rollers which removes the oil or wax and keeps the rollers shiny and will probably overcome this trouble so far as the rollers are concerned.

System Will Require Services of One Man

This process will probably require the services of one man who should have nothing else to do. At times he will probably not be busy but he will have to constantly watch the soaking tank to see that the Brogdite solution is of proper strength, watch all the sprinklers and also take care of the Brogdexing machine.

PLAINTIFFS'-EXHIBIT No. 62

California Fruit Growers Exchange

Field Department Circular No. 78

December 20, 1921.

To all shippers:

Brown Rot

Following heavy rains such as we have had recently, a serious infection and development of brown rot is certain. The worst infection will, of course, occur in the heavier soils on the fruit on the lower branches of the trees. This does not necessarily mean that the fruit trees on the lighter soils will be free from infection, especially after such heavy rains.

The Brown Rot fungus is extremely contagious, spreading to other fruits by contact or through infection of the

[fol. 743] wash water and brushes with this fungus. Infection of sound, unaffected fruit can be effectively prevented through the use of Blue Stone or Copper Sulphate of the proper strength in the wash water in the soaking tanks. The proportion or strength which has been found most satisfactory is 24 ounces to each thousand gallons of water in the morning before starting, and the addition of 16 ounces again immediately after lunch.

Many of our shippers in the past have not exercised enough care in putting in the proper strength of Blue Stone. Some have figured that in cases of this kind if a little is good, more would be better, but it should be at all times remembered that the strength above recommended is practically the maximum strength that can be used without serious injury or burning of the fruit, if the fruit is left in the soaking tank any length of time. The proportion recommended, however, is of sufficient strength to kill all Brown Rot spores or fungus, and there is no need or advantage of using it stronger, provided the proportions above indicated are used both morning and afternoon.

The solution should be made up by suspending a known quantity of Copper Sulphate in a burlap sack in a barrel of water; the sack to be immersed just below the water level. The Blue Stone in this way can be dissolved in the proportion of one or two pounds to a gallon of water. If dissolved in the ratio of one pound to one gallon of water, one gallon of the solution added to each thousand gallons would be 16 ounces to the thousand gallons of water, or the strength recommended for the afternoon run. When putting in the 24 ounce strength for the morning, one quart can be added to each 250 gallons of water, to make the required strength. In this way, by dissolving a known quantity of Blue Stone in a known quantity of water, it is a very easy matter to figure out the proper proportion, and to add the Blue Stone as required.

Never put the crystals loose in the barrel or into the soaking tank. If this is done you never know just what strength [fol. 744] you are using and it may be either too weak or too strong. If it is worth doing, it is worth doing right, and must be done in that manner to get the desired and satisfactory results.

Very truly yours, H. J. Ramsey, Field Manager.

California Fruit Growers' Exchange

Field Department Circular No. 79

December 21, 1921.

To all orange shippers:

Necessity for Greater Care in All Handling Operations

We want again to call the attention of our shippers to the need of the utmost care in the handling of their oranges, both in the field and the packing house, to avoid decay and shrinkage. Our oranges this season are generally thin-skinned, very tender and, after this rain especially, are extremely susceptible to injury and decay. In some districts we find again a great deal of tortrix injury. In addition, we have in some districts much fruit that has been badly wind scarred or injured. Under these conditions the problem of maintaining satisfactory keeping quality is at the best going to be an exceedingly difficult one.

As our Sales Department has indicated to you, nothing more serious could occur at this time than for us to go into a decay period. Only the utmost care and vigilance on the part of our shippers is going to prevent it. Not only will it be necessary to exercise every possible care in picking and all field handling operations, but to exercise every precaution in the way of careful handling in the packing house, particularly at the grading tables to grade out the tortrix and wind injured fruit.

[fol. 745] Picking

Under present conditions, and especially following recent heavy rains, careful picking and field handling is absolutely essential to the maintenance of satisfactory keeping quality. Good picking cannot be obtained without proper supervision. During the past season the most satisfactory work was generally obtained under the quality and quantity bonus system. Circulars have previously been sent to all our shippers explaining in detail the system followed by most of our shippers. The success of this system was due largely to the fact that it meant frequent inspection of each man's work by the Association or shipper; close supervision of each crew, and also that it gave the pickers an incentive to per-

form quality as well as quantity work. No matter what system of payment is used, frequent careful inspection of each man's work is essential, in addition to close supervision of every picking operation. It is none too early for our shippers to give the matter of picking supervision and inspection serious consideration. The more definitely this can be lined up prior to the beginning of the shipping season, the greater assurance you will ~~have~~ of getting off to a good start and of maintaining a satisfactory standard throughout the season.

All equipment, such as picking sacks, clippers and field boxes, should be gone over thoroughly and maintained in an A1 condition. Defective equipment and picking boxes with protruding nails and splinters, and full of gravel and twigs, frequently cause a lot of injury which results in serious decay.

Packing-house Equipment

The packing house equipment should be thoroughly gone over. We have frequently found that worn out, improperly adjusted brushes, protruding nails, splinters and sharp corners have been responsible for much injury and decay. Careful examination before starting of all packing house ma- [fol. 746] chinery, and the path the oranges must follow to the packing bins, and frequent inspection during the season, may prevent a lot of grief both to the shipper and grower.

Every precaution should be taken to get thorough drying. Oranges packed wet or moist furnish ideal conditions for germination of Blue Mold Spores and the development of decay. If oranges are packed wet or moist every injury may develop into decay.

Necessity for Care in Grading

The wind injured fruit has not had sufficient time to heal over to any extent as yet. After rains such as we have had, both the toririx and wind injured fruit is likely to be extremely susceptible to decay. Most careful attention, therefore, must be given to grading out this fruit on the grading tables. Not only will it be necessary to put on extra graders, but in a number of instances to slow down the speed of the belts sufficiently to permit a more careful examination of each orange. The efficiency with which the grading opera-

tions is handled in this respect will largely determine the keeping quality of the fruit and the returns to our shippers.

Presorting Decayed Oranges

Special attention should be given to sorting out all decayed fruit before it goes into the soaking tank, the brushes, or through the machinery. You cannot depend upon Blue Stone in the washwater to kill Blue Mold spores. All Blue Mold oranges going into the soaking tank, through the brushes and machinery, will serve to inoculate every orange with Blue Mold.

Removal of Decayed Oranges from the Packing-house

The packing house should be kept free and clean as possible of all decayed fruit. Nothing is more dangerous than to leave Blue Mold oranges lying around on the floor, under the sizers, the washing machines, or standing around in boxes. A packing house kept clean of decayed fruit will [fol. 747] greatly reduce the chance of infection and make for better and more efficient work all along the line.

Very truly yours, H. J. Ramsey, Field Manager.

California Fruit Growers' Exchange

Field Department Circular No. 104

Los Angeles, Cal., Jan. 4, 1924.

To all orange shippers.

GENTLEMEN:

Carefully Handling This Season More Than Ever Necessary

In addition to the usual problems in the handling of our Navel crop with a view to minimizing decay, we have this year an unusually smooth and thin skinned fruit to handle. This being the case, it will be necessary for our shippers to exercise the utmost care in the handling of the fruit from the field to the car if anything approaching dependable keeping quality is to be obtained.

In addition to being thin skinned, much of it has been badly wind-whipped and injured on the trees. Even before the wind occurred and before we had had any rains, we were getting reports of slight to heavy decay in Navels from

both Southern and Northern California. With no unfavorable weather conditions to contend with these shipments with ordinary care and handling should have gone through in sound condition were it not for the fact that the fruit this year is extremely susceptible to injury and decay.

Splits and Badly Injured Fruits Should be Eliminated in the Field

Special care should be exercised by the picking inspectors and foremen of picking crews to eliminate all splits and other badly injured fruits from the picking boxes since it is [fol. 748] a much easier matter to eliminate fruit of this character in the field than at the dump or on the grading table where in many instances it arrives badly affected with Blue Mold.

Other Precautions in Handling Fruit in the Field

Since the thin skinned fruit of this year will be far more than usual susceptible to injury, foremen should be instructed to see that all litter and gravel be removed from picking boxes before being used: also that the boxes are in good order and that there are no protruding nails or splinters. More than the usual care should be taken to guard against filling boxes too full since this will result in injury to fruit when stacking in the field, on the wagon and again in the house. Not only will injury occur in stacking but also when the boxes are being removed for dumping. All pickers should be required to wear gloves to avoid finger nail injuries. They should be supplied with clippers that are properly adjusted and in good working order. This, with the utmost care on the part of the picker, will go far toward minimizing clipper cuts and long stems, as cuts, punctures and scratches will this year undoubtedly result in more serious decay than during years when fruit is not so thin skinned and tender.

Sweating

We do not advise the sweating of fruit where practically no green shows even though the orange may be somewhat pale in color. Sweating of pale fruit at times appears to give somewhat higher color while at other times it does not; in any event, we feel the advantage that may be gained by the

sweating of fruit of this character will be more than offset by the additional risk of decay that may develop by reason of the extra time fruit must remain in the packing house, the injury in trucking back and forth and, in many instances, injury resulting from sweating improperly done. Under no circumstances should fruit be run direct from the sweat rooms into the water tanks, no matter what method of sweating may be used, without first thoroughly ventilat- [fol. 749] ing the fruit from 12 to 24 hours. When tents are used, unless they are made of exceptionally heavy material, the fruit usually receives plenty of ventilation. With board and heavy papered rooms, when using stove gas, have rooms well ventilated at all times except the first few hours when closed. Where ethylene gas is used, ventilate thoroughly 20 minutes before each application of gas. Generally speaking, 1 cubic foot of ethylene gas to each 5000 cubic feet of air space twice a day will be found sufficient, although many prefer to shoot the rooms 3 or 4 times a day with correspondingly less gas at each application, thus giving the rooms more frequent ventilation. Temperatures should preferably be from 70 to 75 degrees; humidity from 75 to 80 degrees.

Eliminate Decayed Fruit at the Dump

A man should always be stationed at the dump to pick out any fruit showing signs of Blue Mold which may have developed either from fruit remaining on the floor an unusual length of time or fruit from the sweat rooms. However, as before mentioned, a very large percentage of fruit can and should be eliminated in the field, since regardless of the amount of care that may be exercised at the dump, a certain percentage of this infected fruit will pass; also where Blue Mold has developed in the picking box, the moving of these boxes about either by hand or by truck causes the Blue Mold to sift down and cover many if not all oranges in the box. This Blue Mold passes through the water tank and all the machinery and no amount of care will prevent a certain amount of inoculation in case there is any injured fruit.

Brown Rot

Following rains, we may expect some occurrence of Brown Rot which is very infectious. We would, therefore, sug-

gest that all shippers be on the lookout for the first appearance of this fungus and that Blue Stone be used in the following manner and proportions:

Make a stock solution in the proportion of 1 pound of Blue Stone to 1 gallon of water. (Do not place the crystals [fol. 750] directly in the tank). Use the stock solution in the proportion of 1½ pounds Blue Stone to 1000 gallons of water in the soaking tank.

Tortrix

Some reports have been received showing the presence of Tortrix in certain localities.

By reason of injuries by the Tortrix worm being deeper than ordinary injuries, a much larger percentage of fruit injured in this manner is likely to develop decay. There is but one way to eliminate injuries of this kind and that s at the grading table. Here should also be eliminated all badly wind-whipped fruit. This will require additional help on the table with corresponding increase in the cost of grading. We feel, however, that this amount will be returned many times in the eliminating of injured fruit and the corresponding minimizing of decay.

The Utmost Care Necessary

With the character of fruit we have to handle this season, as above explained, it will require the utmost care on the part of our shippers in both the field and packing house to avoid very serious losses from decay. Especially is it important that particular attention be given to the field handling and eliminating injured fruit on the grading belt.

Picking Inspectors

The Exchange is putting on 4 picking inspectors to cover certain districts. These inspectors will work with our associations in an effort to assist them in maintaining the most efficient and careful work in field handling consistent with commercial practice. As soon as the inspectors are appointed and put on, we will advise our shippers in the different territories in order that arrangements can be made for getting this work under way immediately.

Very truly yours, Field Department.

[fol. 751] California Fruit Growers' Exchange

Field Department Circular No. 107

Los Angeles, Cal., April 8, 1924.

To all shippers.

GENTLEMEN:

Navels—Ripe and Tender

In most districts, Navels are thoroughly ripe and show more than the seasonal tendency to crease or puff, causing the fruit to become very soft and tender. This condition is more serious than usual following the late period of damp weather and general rains in the citrus belt.

In order that we may maintain a good commercial pack and sound arrival condition, extraordinary care should be exercised at the press and in all other handling operations else we are likely to suffer heavy decay during the wind-up of the Navel season. While decay may not always be so evident on arrival, fruit of the above character is likely to deteriorate rapidly as soon as it is removed from the refrigerator cars unless the utmost care is exercised in preparing it for shipment.

Brown Rot

Brown Rot is showing up in some districts. While up to this time it has not been serious we may have a decided increase in decay from this cause following the recent rains. We would strongly urge all shippers to use the hot water or blue stone treatment for Brown Rot. The formula for blue stone is as follows:

1½ pounds to each 1000 gallons of water in the morning.
1 pound to each 1000 gallons of water at noon.

This strength is sufficient; a stronger solution might result in burning injury. The crystals of copper sulphate should never be placed directly in the soaking tank. A stock solution can be made up in the proportion of 1 pound [fol. 752] of copper sulphate to 1 gallon of water and the required quantity can be applied in units or parts of a gallon.

Hot water may be used at a temperature of 115 to 120 degrees instead of blue stone. Care should be used to not permit the water to go above 125° F. or fruit to remain in the water an unusual length of time, that is during the noon hour or shut-down for other reasons. Unless a uniform temperature be maintained the use of blue stone would be safer. When using blue stone, double the ordinary amount of soap should be used in the soaking tanks. An added precaution is to place a man at the dump to remove all infected oranges before they go into the soaking tank or before they go through any of the machinery.

Importance of Thorough Drying

We have in some districts an unusual number of wind-scarred and wind-injured oranges. Especially during the present damp and rainy weather the greatest care should be exercised to eliminate the very large and deep scars from our better grades for the reason that such fruit usually absorbs so much moisture that it is impossible to remove it in the dryers. In order to prevent serious losses from decay, every effort must necessarily be made to thoroughly dry the fruit before it is packed. Where possible, packing should not immediately follow rains but fruit should be permitted to dry on the trees since wind and sunshine are usually more efficient than dryers. In addition to that, fruit that is dry on the trees can be handled with less injury and less liability to decay than when it is damp or wet.

[fol. 753] PLAINTIFFS' EXHIBIT No. 63.

Office of Fruit Growers Supply Company

Circular No. 524

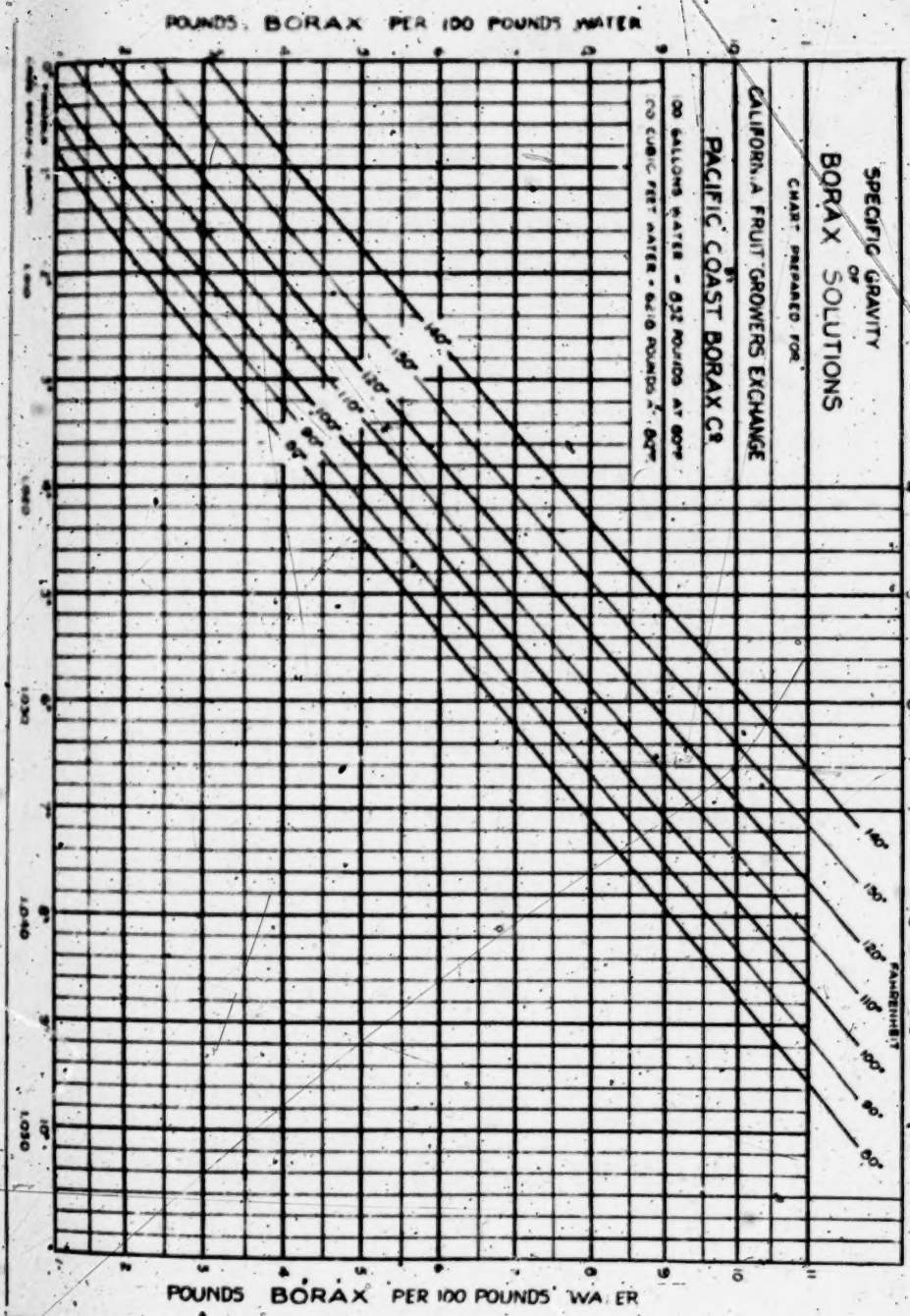
To all associations, exchanges and contract shippers (members of the Supply Company).

GENTLEMEN:

Box Strapping

Kindly note change in billing-out price on box strapping. The new figure is $13.50 per coil f. o. b. Los Angeles and represents a reduction of 50¢ over the old price.

PLAINTIFF'S EXHIBIT NO. 64. 755 - 756



Your attention is also called to a change in the terms to apply on and after February 5th. Thirty days net term has now been adjusted to allow 2% 10 days from date of invoice.

The announcement of reduced price was delayed to allow consummation of purchase negotiations which are now complete and justify application of the adjustment as of January 1st. Accordingly, credit memoranda have been issued on all purchases since that date.

Borax

A contract has been concluded by which it is possible for associations to purchase granulated borax in 18-ton carload lots at a price of $4.45 per hundred pounds f. o. b. any destination in southern California. The price in less carload lots is $4.75 per hundred pounds ex-warehouse, Los Angeles. These figures are subject to a discount of 2% 10 days from date of invoice.

When the carriers' charges are taken into consideration it will readily be seen that it will be to the advantage of [fol. 754] our associations to pool their orders wherever possible in such a way as to take shipment in full carload lots. Requirements should be anticipated as far as practical in order that there may be no delay in delivery.

Very truly yours, ~~Albert~~ M. Paul, Assistant General Manager.

Los Angeles, Calif., Feb. 16, 1925.

(Here follows diagram, side folios 755 and 756.)

[fol. 757] PLAINTIFFS' EXHIBIT No. 65

Chase & Co., Carlot Distributors Citrus Fruits and Vegetables, Orlando, Florida

January 10, 1927.

Florida District Agents, Chase & Company.

GENTLEMEN:

Summary

Decay Analysis

Period Nov. 23rd to Dec. 14, 1926

District	No. cars shipped	No. cars decay	Per cent show dk.	Avg. decay shown	Avg. days enroute
Arcadia	13	3	23%	11%	12
Crescent City	33	9	27%	10%	9
Dunedin	33	3	9%	9%	14
Frostproof	15	2	13%	9%	10
Geneva	28	11	39%	10%	9
Nocatee	15	3	20%	7%	9
Ocoee	18	4	22%	11%	10
Orlando	17	4	24%	7%	10
Sanford	25	4	16%	7%	9
Terra Ceia	13	6	46%	14%	13
Wauchula	25	6	24%	9%	9

By the above analysis you will note we are attempting to figure out what our decay problem meant in the period from November 23rd to December 14th, 1926.

The first column of figures indicates the total number of cars shipped by each district for the period. The next column indicates the number of cars that showed decay in that period. The third column shows the percentage of cars shipped during this period which arrived showing any decay of consequence. In other words, 23% of the Arcadia shipments arrived showing decay, whereas only 9% of Dunedin shipments arrived showing decay. The next column shows the average decay in those cars which arrived [fol. 758] showing decay. In other words, 23% of Arcadia shipments arrived showing an average decay of 11%, the balance of the shipments being practically sound. 46% of Terra Ceia shipments showed decay. The average decay of this 46% of Terra Ceia shipments showing 14%. In

the next column is indicated the number of days enroute on an average for these decay cars.

Terra Ceia, which has the worst record having neary one-half of these cars showing decay, and this half showing 14%, did not use borax. Geneva, which is the next worst record, discontinued the use of borax during quite a proportion of the days analyzed. Crescent City, which would come next, did the same thing. You will notice that Crescent City and Geneva both show only 9 days average enroute on these decay cars. The time enroute was longer than it should have been, nevertheless part of the delay was unavoidable due to the trade's unwillingness to buy, or make offers. Nevertheless, Dunedin which shows in its decay cars the greatest number of days enroute also holds the record for showing the least percentage of decay, when the percentage is applied to its proportion of cars.

We are passing this analysis to each of our district managers asking that you in turn analyze this problem and offer any further suggestions. Offhand our conclusions would be, those houses who thoroughly and conscientiously used the concentrated solution of borax certainly reduced their proportion of decay.

The foregoing conclusions are purely tentative. I am asking Mr. S. O. Chase, Mr. Skinner and any of the rest of you who are interested to offer further evidence or conclusion, and if there is any material change another final analysis and conclusion will be given you.

Yours very truly, Chase & Company, by A. M. Pratt.

AMP-h.

[fol. 759] PLAINTIFF'S EXHIBIT No. 66

United States Department of Agriculture, Bureau of Plant Industry, Washington

Fruit-Disease Investigations, Box 491, Orlando, Florida

November 17, 1924.

Mr. J. B. Skinner, Dunedin, Florida.

DEAR SIR: Probably you have read the article in the November 1st number of the Florida Grower on the borax treatment of citrus fruit to prevent rot. Since this was

written we have gotten results from additional tests that are even more promising.

Below are given the average results on five recent tests on pre-colored oranges three or four days from the tree. The fruit had been washed, graded and sized before we took the samples. It was third grade fruit, and we held it at around 70° F. to make the test severe. The borax solution was 5% (at the rate of one pound borax to 2½ gallons water) and the fruit was soaked for 5 minutes. The "cold borax solution" was at ordinary room temperature, and the "hot borax solution" was at 120° F. The figures give percentages for the first 12 days from the taking of the samples, or from packing.

	All rots	Blue-mold rot	Stem-end rot
Untreated	37%	7%	30%
Cold Borax Solution	16%	1%	15%
Hot Borax Solution	6%	0%	6%

If you wish further information on the subject I would be glad to hear from you.

Yours truly, H. R. Fulton, Pathologist.

HRF:L.

[fol. 760] PLAINTIFF'S EXHIBIT No. 67

License Agreement

This agreement, made and entered into this 9th day of September, 1924, by and between Brogdex Company, a corporation of Florida, having places of business at Los Angeles, California, and Winter Haven, Florida, owners of a composition and method of washing citrus fruit, known as "Brogdite" and having as its purpose retardation of decay arising from blue mould development, to which such fruit may be subject; likewise owners of a composition and method for treating citrus fruit, preparatory to marketing, known as "Brogdex", and having as its purposes the improvement in the appearance of, and retarding shrinkage and withering of, citrus fruit, Party of the First Part, hereinafter designated licensor, and Mutual Orange Distribu-

tors, a corporation duly organized under the laws of the State of California, and having its principal place of business at Redlands, California, Party of the Second Part, hereinafter designated Licensee,

Witnesseth:

That, for and in consideration of the covenants and agreement of the licensor and of the licensee, hereinafter set forth, to be kept and performed, and of the payment by licensee of all moneys as and when due under the terms hereof, the licensor hereby licenses the licensee to use, from the date hereof until the termination of this Agreement as hereinafter provided, at any and all of its packing houses in California and Arizona, or elsewhere, the compositions and methods, or processes, of the Licensor, known respectively by the trade name "Brogdite" and "Brogdex", on the following terms and conditions, to-wit:

Section 1

Licensor agrees to make any and all alterations, removals or changes in the equipment and machinery in use in the [fol. 761] packing houses affiliated with licensee necessary to install all and adequate machinery and equipment necessary for the application of "Brogdite" and "Brogdex", and licensor agrees to install in all the packing houses affiliated with the licensee suitable equipment for the application in an efficient manner of said "Brogdite" and "Brogdex", said equipment and machinery, together with all materials, to be of sufficient capacity and amount to handle the total tonnage and output of each of said houses; and said licensor agrees to use its best efforts to complete said installation within a reasonable time after written request is received from licensee designating the packing houses in which installation is desired, as well as the character of the equipment required for the capacity of the plant. Licensor will install said equipment in such packing houses and will operate said equipment during the trial tests. Licensor will supervise the operation of said equipment during instruction of employees of licensee in the use and operation thereof.

Licensor will, during the life of this Agreement, furnish licensee all materials, other than water, constituting licensor's formulas for "Brogdite" and "Brogdex", and

will maintain said equipment in good repair, the expense of any and all changes, alterations, repairs and replacement of parts of said equipment to be borne by licensor.

It is agreed that the correcting of defects in said equipment by repair or replacement by Licensor shall constitute a fulfillment of all obligations to Licensee regarding said equipment; this agreement to replace and repair being in lieu of all warranties not expressly made a part of this contract. Licensor shall not be held responsible for any loss, damage, detention or delay in connection with the shipment of citrus fruit from said packing houses, or any of them, arising out of or resulting from the inability to use said equipment while necessary repairs are being made. [fol. 762] All equipment furnished to Licensee by Licensor under this contract is loaned by Licensor and shall remain personal property, and the title and ownership thereof shall be and remain solely in Licensor; upon termination of this Agreement said apparatus shall be removed from said packing house or houses by Licensor immediately or within thirty days after such termination, at its option.

Except as herein otherwise provided, said equipment shall be operated and said processes shall be applied by Licensee and its employees.

Section 2

Licensee agrees to pay Licensor on or before the last day of each calendar month a license fee or royalty of 6½ cents per standard packed box of oranges of all grades above culls shipped for any of its said packing houses, and 6½ cents per standard packed box of any other citrus fruit of grades above culls treated with said processes, or either of them, in any of its said packing houses and shipped by Licensee during the next preceding calendar month, until such time as each packing house of licensee using said processes shall have paid for 400,000 boxes at said royalty rate, and thereafter Licensee shall pay to Licensor a license fee or royalty of 5½ cents per standard packed box of oranges of all grades above culls shipped by licensee and 5½ cents per standard packed box of any other citrus fruit of grade above culls treated with said processes, or either of them, and shipped by licensee during the next preceding calendar month.

It is understood and agreed that the royalty payments hereinabove provided for shall not commence until the completion of the installation of said machinery and equipment, in accordance with Section 1 hereof, in said packing houses in operating condition satisfactory to Licensee, and Licensee shall give Licensor written notice to that effect as to each and every house in which installation is made.

[fol. 763]

Section 3

During the life of this agreement, Licensee agrees to keep an accurate record of the number of standard packed boxes of oranges, of all grades above culls, shipped by said packing houses affiliated with said Licensee using the equipment and processes of Licensor; also a record of the number of standard packed boxes of other citrus fruits treated by said processes, or either of them, and shipped by the Licensee, and shall furnish to Licensor a statement or statements on or before the last day of each calendar month, which statement shall disclose the exact number of standard packed boxes, of all grades above culls, treated by said processes, or either of them, and shipped by Licensee for any of its affiliated houses during the next preceding month; and said records of Licensee shall be available for inspection by a representative of Licensor at all reasonable times.

Section 4

Licensor will, upon request, supply Licensee, without charge, with suitable labels or rubber stamps bearing the trade names "Brogdite" and "Brogdex", and licensee may place said labels or stamps on standard packed boxes of fruit graded to any standard grade above culls treated under this Agreement, but the use of the names "Brogdite" or "Brogdex" on boxes of fruit of any grade lower than standard grades above culls, or upon unsound fruit of any grade, or upon fruit not treated with "Brogdite" or "Brogdex" is hereby expressly prohibited.

Section 5

In the event Licensee is unable, during any period in the life of this Agreement, to use the machinery, equipment

and processes which are the subject matter of this Agreement, by reason of any defect in said machinery or equipment, for which Licensor is responsible, or by reason of any failure on the part of Licensor to furnish the materials [fol. 764] referred to in Section 1 hereof, for which Licensor is responsible, subject to the provisions of Section 1, or for any other reason properly chargeable to Licensor, no license fees or royalties shall be paid by Licensee for oranges or other citrus fruits run through any packing house of Licensee during said period without being treated with said processes, or either of them; provided, however, that in such event it shall be the duty of Licensee to immediately notify Licensor of any such defect in machinery or equipment or delay in furnishing materials, or any other cause rendering it impossible to use said machinery, equipment and processes.

If Licensee at any time shall believe and decide that "Brogdite" or "Brogdex", or either of them, or the equipment, machinery or materials used in connection with their application, are unsatisfactory, then said Licensee shall give Licensor notice of said dissatisfaction and if Licensor within thirty days thereafter fails to correct the causes of said dissatisfaction in a manner satisfactory to Licensee then Licensee shall have the right to immediately cancel this Agrement, and shall give Licensor written notice of such cancellation, and Licensor shall thereupon remove said equipment, machinery or other apparatus within thirty days. This provision shall be in addition to the cancellation rights set forth in Section 11 following.

Section 6

Licensor represents that it is the owner of the compositions and methods herein designated as "Brogdite" and "Brogdex"; that the processes and equipment contemplated hereby are covered by United States letters patent and/or by application for such letters patent now pending and owned or controlled by Licensor, and Licensor agrees to indemnify and save harmless the Licensee against any liability or judgments arising out of or resulting from any suit brought by third parties against Licensee involving the right of Licensee to use the machinery, equipment and

processes herein mentioned during the life of this Agree-
[fol. 765] ment. In the event any suit is brought by third parties against Licensee involving its right, during the life of this Agreement, to use the machinery, equipment and processes herein mentioned, the Licensee shall give Licensor prompt notice thereof in writing and shall forward to Licensor, immediately upon receipt thereof, all papers served upon the Licensee in connection with such suit, and Licensor hereby agrees to diligently defend, at its own expense, any and all such suits and to keep Licensee promptly advised in all matters relating to the conduct of such litigation, provided, however, that Licensor shall have the right to conduct the entire defense of such suit.

In the event the Licensee is prevented by legal process from using said machinery, equipment and processes in its said packing house, Licensee shall not pay any license fees or royalties herein provided for upon oranges and other citrus fruit run through said packing house during the period in which Licensee is so prevented from using said machinery, equipment and processes, provided, however, that Licensee shall not be entitled to claim or recover any damages from Licensor by reason of being so prevented from using said machinery, equipment and processes.

Licensee hereby acknowledges the title of Licensor to said processes, compositions and methods and any improvements, alterations and changes in the same, and expressly agrees never to set up any claim assailing or tending to assail said title of Licensor.

Nothing herein contained shall be construed to prevent Licensee from using or dealing with other parties for the use of the same or similar processes in the event the patents of Licensor are finally determined by the proper judicial tribunal to be invalid, or said processes are similarly finally determined to be unpatentable, or are similarly finally determined to be owned by parties other than the Licensor.

[fol. 766] Section 7

Licensor agrees to maintain at its own expense a research and experimental laboratory for further developing and perfecting, if possible, the formulæ and equipment which are the subjects of this Agreement. It is hereby under-

stood and agreed that member packing houses of Licensee using the said machinery, equipment and processes shall, during the life of this Agreement, be entitled to have installed any improvements in equipment or processes perfected and found desirable for use by Licensor.

Section 8

It is mutually understood and agreed that it is essential to the successful application and use of the "Brogdite" and "Brogdex" processes that the solution be compounded in the proportions prescribed in the instructions to be given by Licensor from time to time, and that said solutions and processes be applied strictly in accordance with said instructions.

Licensee hereby agrees that a representative of Licensor shall have access, at all reasonable times during the life of this Agreement, to the packing houses of Licensee for the purpose of determining that said "Brogdite" and "Brogdex" processes are being used in accordance with the instructions of Licensor. In the event that such representative shall at any time find, upon inspection of the operation of said packing houses, or any of them, that Licensee is not compounding said solution and/or applying said processes, or either of them, in accordance with the instructions of Licensor last given, he shall so report to the manager o fany packing house in which such condition is found to exist, and Licensee shall thereupon cease to apply said "Brogdite" process and/or "Brogdex" process in any manner other than embodied in such instructions, unless a representative of Licensor shall have approved the modication by Licensee of the instructions last given by Licensor.

[fol. 767] Section 9

Licensee agrees to treat all oranges of grades higher than culls, run through said packing house, with the "Brogdite" process, and may treat all oranges of grades higher than culls where the condition of the color of said oranges warrant the same, with the "Brogdex" process during the life of this Agreement and the license fees or royalties, payable under Section 2 hereof, are based upon the conclusive presumption that the "Brogdite" process has been

applied to all oranges of grades higher than culls run through said packing houses during the life of this Agreement, except as herein otherwise provided.

Section 10

Licensee hereby expressly agrees that the machinery, equipment and processes herein mentioned shall not be used in connection with any other process for retarding blue mold decay or shrinkage or withering of fruit, or for any other purpose not covered by this Agreement.

It is hereby understood and agreed between the parties hereto that Licensor assumes no responsibility for and will not be liable for loss or damage of any kind to Licensee arising out of or resulting from the installation or use of said machinery and equipment or said processes, or either of them, except as herein otherwise provided.

Section 11

Licensee may cancel this Agreement as to any of its member packing houses using said machinery, equipment and processes, such cancellation to be effective on the first day of November of any year by giving at least thirty days' written notice to Licensor to that effect, but such cancellation shall not relieve the Licensee from any obligation incurred hereunder prior to the effective date thereof. Cancellation by any member packing house of Licensee shall [fol. 768] not affect the rights of Licensee hereunder as to other member packing houses in the use of said machinery, equipment and processes.

In case any packing house affiliated with Licensee which may be using these processes, or either of them, machinery and equipment, shall for any reason cease to be affiliated with said Licensee, then said packing house shall immediately cease to use said processes and machinery, and Licensor shall have the right to enter said packing house and remove said machinery and equipment. Licensor agrees that it will not contract with said packing house which has ceased to be a member of Licensee for the use of said processes, or either of them, or the machinery used in connection therewith, either upon a license, royalty, sale or rebate basis, excepting in accordance with the spirit and provisions of Section 13 hereof.

Licensee agrees to use due diligence in maintaining its packing house machinery in such condition that citrus fruit run through said packing houses will not be mechanically injured; Licensee further agrees that if attention is called to defects in the machinery of said packing houses, or any of them, likely to cause or causing mechanical injuries to citrus fruit run over said machinery, Licensee will use all reasonable efforts to correct such defects to the end that mechanical injuries to citrus fruit run over said machinery shall be reduced to a minimum.

It is hereby mutually understood and agreed that the machinery and equipment referred to in Section 1 of this Agreement is designed and constructed particularly for the treatment of citrus fruit other than lemons, and that machinery and equipment of special design is manufactured by Licensor for the treatment of lemons. Licensee expressly agrees that, if any lemons are run through said packing houses, or any of them, using the machinery and equipment for applying "Brogdite" and "Brogdex" processes herein referred to, the boxes in which such lemons [fol. 769] are shipped to market shall not contain any marks or labels indicating that they have been treated with either "Brogdite" or "Brogdex."

Section 12

Time is of the essence of this contract, and should the Licensee fail to observe any of the conditions herein set forth or to fulfill any obligations arising under this license agreement, written notice of such default shall be given to Licensee by a letter mailed to Licensee at its principal place of business at Redlands, California, and in the event such default is not cured within ten days from receipt of said notice, Licensor may, at its option, hold this Agreement terminated as to the packing house or packing houses of Licensee so indefault, and all rights and privileges of Licensee under this Agreement, as to the packing house or houses in default, upon exercise of said option by Licensor, shall cease and determine, but Licensee shall not thereby be relieved from any obligation or liability under this Agreement, as to such packing house or houses, accrued at the date of such termination. Any waiver by Licensor of the right to terminate this Agreement as above set forth shall

not be construed as a waiver of said right upon a further breach of the conditions or obligations of this Agreement by Licensee.

Section 13

Licensee hereby agrees to use its best efforts to secure the adoption of said "Brogdite" and "Brogdex" processes by all its member packing houses, and the terms and conditions of this contract shall be applicable to and shall be enjoyed by any and all packing houses which may become members of Licensee at any time prior to such time as Licensee shall handle at least twenty per cent of the total annual crop of oranges and grapefruit in California and Arizona. Licensor agrees that it will not enter into any contract for the installation of its equipment and/or the [fol. 770] use of its processes in citrus packing houses in California or Arizona, except such packing houses as have previously contracted with Licensor and its predecessors in interest for the use of the "Brogdex" process, a list of which is hereto appended and made a part hereof, upon terms as favorable as to license fees or royalties as are contained in this Agreement. Licensee, and packing houses which may become members of Licensee, as well as packing houses already holding contracts for the use of the "Brogdex" process, entered into with Licensor or its predecessor in interest, shall be entitled to a preferential in license fees or royalty payments of not less than one cent per standard packed box over any and all packing houses or associations in California or Arizona hereafter contracting with Licensor for the use of its machinery, equipment and processes, in consideration of the early support accorded to Licensor, by said parties, in the development and establishment of its business, and Licensor agrees not to sell or contract for the sale of its machinery, equipment and/or processes upon such terms as would defeat said preferential provision, nor shall Licensor defeat the spirit and intent and provisions of this section by making rebates to any party or parties with whom it may contract for said processes.

Section 14

It is expressly understood and agreed that this Agreement constitutes the sole contract and agreement between the parties hereto, concerning the matters herein stated, and that there is no verbal contract or understanding modifying the same.

Section 15

This Agreement shall be binding upon and inure to the benefit of the parties hereto, their successors and assigns.

In witness whereof the parties hereto have caused these [fol. 771] presents to be executed in duplicate the date first hereinabove written, each by its proper officers thereunto duly authorized.

Brogdex Company, by W. J. Wallace, President, by W. R. Millar, Secretary. (Seal.) Mutual Orange Distributors, by J. H. Strait, President. By A. B. Cowgill, Secretary. (Seal.)

List of Packing-houses in California under Contract with Brogdex Company for Use of Brogdex Process Referred to in Attached Agreement

Arlington Heights Fruit Company, Riverside, California.
Highgrove Fruit Exchange, Highgrove, "
Rialto-Orange-Lemon Association, Rialto, "
Azusa Orange Company, Azusa, "
San Antonio Fruit Exchange, Pomona, California, representing College Heights Orange & Lemon Association, Claremont Citrus Association, El Camino Citrus Association, Pomona Fruit Growers' Exchange, Walnut Fruit Growers' Association, Indian Hill Citrus Association, West Ontario Citrus Association.

[fol. 772] Plaintiffs' Exhibit No. 68

License Agreement

This agreement, made and entered into as of the 18th day of June, 1926, by and between Brogdex Company, a

corporation duly organized and existing under the laws of the State of Florida and having places of business at Winter Haven, Polk County, Florida, and Los Angeles, California, Party of the First Part, hereinafter called "Company", and Skinner Machinery Sales Company, a corporation duly organized and existing under the laws of the State of Florida and having its place of business at Dunedin, Florida, Party of the Second Part, hereinafter called "Licensee",

Witnesseth:

That, Whereas the Company owns the entire right, title and interest in and to certain new improvements and inventions in the preparation of fresh fruits for marketing, covered by United States Letters Patent No. 1,529,461, of March 10, 1925, and applications for patents pending, of which letters patent and applications pending said Company is sole owner, and desires to introduce the use of said processes in connection with the citrus industry in the State of Florida, and

Whereas, Licensee has an established business organization in the State of Florida, manufacturing citrus packing house machinery and equipment, and desires the exclusive license in the State of Florida to manufacture the Company's machinery and equipment and to license the use of the same, together with the Company's processes, known as "Brogdite" and "Brogdex", upon citrus fruit and no other fruit or vegetable, to parties engaged in the citrus industry in Florida for the full life of all letters patent of the United States obtained or to be obtained therefor or thereupon, said improvements and inventions for convenience being [fol. 773] hereafter referred to as "Brogdex System":

Now, Therefore, in consideration of the premises and in consideration of the covenants and agreements entered into as hereinafter set forth and the faithful performance of the same, the parties hereto have agreed and do hereby agree as follows:

1

Said Company hereby grants to said Licensee the exclusive license and right for the State of Florida, and not elsewhere, to use and market all the inventions and improvements aforesaid for citrus fruit only, until the end of

the term of the last letters patent of the United States to be granted therefor or thereupon, subject to the terms and conditions hereinafter set forth.

2

Licensee covenants and agrees to pay to the Company royalties or license fees on all citrus fruit treated under the Brogdex System in the State of Florida, said royalties or license fees to be as follows:

(a) On all citrus fruit two and one-half cents (2½¢) per standard box or crate of 1-3/5ths bushels capacity in all cases where Licensee contracts with third parties for the use of Brogdex System at a royalty rate of six cents (6¢) or less per standard box, exclusive of royalties provided for in said contract to cover Licensee's charges for manufacture and installation of machinery and equipment.

(b) In all cases where Licensee contracts with third parties for use of the Brogdex System at a royalty rate in excess of six cents (6¢) per standard box, exclusive of royalties provided for in said contract to cover Licensee's charges for manufacture and installation of machinery and equipment, Licensee agrees to pay the Company, in addition to said royalty or license fee of two and one-half cents [fol. 774] (2½¢), fifty per cent (50%) of any and all royalties charged in excess of six cents (6¢) per standard box, exclusive of royalties provided for to cover Licensee's charges for manufacture and installation of machinery and equipment.

(c) In the event that any or all of the materials, equipment or supplies now owned by the Company and located in its place of business at Winter Haven, Florida, are sold to and purchased by Licensee, the Licensee hereby agrees to pay the Company the cost thereof, as shown by the books of account of said Company, plus ten per cent (10%) upon presentation of bills therefor, together with all charges for delivery to Licensee.

3

Licensee covenants and agrees that in all contracts with citrus packing organizations, entered into by Licensee here-

under, during the present citrus season of 1926-1927, for the use of the Brogdex System, the royalty or license fee to be paid for the use of said Brogdex System shall not be in excess of six cents (6¢) per standard box exclusive of royalties provided for to cover Licensee's charges for manufacture and installation of machinery and equipment; provided, however, that in any and all contracts entered into between Licensee and third parties, for the use of the Brogdex System, provision may be made for payment to Licensee of its charges for manufacture and installation of machinery and equipment at a rate not to exceed three cents (3¢) per standard box.

4

Licensee covenants and agrees not to enter into any contracts with third parties for the use of the Brogdex System after the citrus season of 1926-1927, at a royalty rate in excess of six cents (6¢) per standard box, exclusive of royalties provided for to cover Licensee's charges for man-
[fol. 775] ufacture and installation of equipment, without the written consent of the Company first had and obtained; provided, however, that Licensee shall have the right, as to any and all contracts entered into with third parties hereunder, to fix the term thereof.

5

Licensee covenants and agrees that the royalty or license fees due and payable to the Company under this agreement shall amount to not less than the sums hereinafter set forth, to-wit:

For the 5 months ending November 30, 1926	$25,000.00
For the year ending November 30, 1927	50,000.00
For the year ending November 30, 1928	75,000.00
For the year ending November 30, 1929, and for each year thereafter that this agreement remains in force	125,000.00

and Licensee covenants and agrees to pay the Company one-twelfth (1/12th) of said minimum royalty or license fees within twenty (20) days after the end of each and every calendar month during the term of this agreement, together with any and all additional royalty or license fees due and

payable to the Company from operations during the previous calendar month, all remittances to be made in current funds of the United States.

In the event Licensee shall default in making the minimum royalty payments hereinabove provided for, then, if such default be not made good in accordance with the provisions of Paragraph 16 of this agreement, all rights herein granted to Licensee shall immediately be forfeited and shall revert to the Company, and this agreement shall cease and determine. Upon such termination of this agreement, Licensee shall, upon the request of the Company, assign to the Company all its right, title and interest in and to any or all contracts and agreements made hereunder with third parties in the State of Florida, and to that end shall execute [fol. 776] or cause to be executed, by its proper officers thereunto duly authorized, assignments, bills of sale or other instruments necessary or convenient to transfer full and complete title and ownership from Licensee to the Company in said contracts, as well as in all machinery and equipment installed or to be installed in citrus packing houses in the State of Florida under said contracts with third parties in said State, and all materials, supplies and equipment on hand. Licensee shall not, however, by such termination of this agreement, be relieved of any obligation or liability under this agreement accrued at the date of such termination thereof; provided further that, if Licensee at the date of such termination shall be in default in the performance of any of the covenants or conditions in any of said contracts with third parties in the State of Florida on its part to be kept and performed, Licensee shall, with due diligence, make good any and all such defaults before said contract shall be assigned to the Company, as herein provided, to the end that the Company shall not assume or be responsible for any liability or obligation of Licensee accrued thereunder at the date of such assignment or assignments.

6

Licensee shall keep true and complete records at a convenient and accessible place of business, showing all citrus fruit treated by the Brogdex System, and shall preserve all information relating to the proper accounts incident to the establishment of the rights between the parties hereto, and all such records, books of accounts and other information

shall be open to inspection at all reasonable times by the Company or its duly authorized representatives; and Licensee shall send to the Company on or before the 20th of each month a report (under oath, if required by the Company) showing the exact amount of fruit treated during the preceding calendar month. All contracts made by Licensee with third parties for the use of the Brogdex System shall [fol. 777] provide that accurate records of all fruit treated by said system shall be kept by said third parties and a statement presented to Licensee monthly, and that Licensee shall have access to all such records.

7

The Company covenants and agrees to give Licensee the benefit of any future improvements or inventions which may be owned or controlled by the Company and which are valuable in connection with the use of the Brogdex System, and to furnish free all information had by the Company relating to the proper use of the inventions, machinery, equipment and processes comprising said system; also to grant to Licensee the free use of all data and testimonials and the benefit of all experiments made or conducted by the Company, which may prove beneficial to Licensee.

8

Licensee agrees, at its own cost and expense, to carry on such advertising campaign in the State of Florida as shall be reasonably necessary or useful in extending and developing the use of the Brogdex System of the treatment of citrus fruits, and to that end may make any and all necessary or convenient arrangements with third parties contracting for the use of said Brogdex System for sharing the expense of advertising said system, processes and fruit treated thereunder. The Company shall have the right, at its option, to specify the character and contents of any advertising material used or to be used by Licensee in extending and developing the use of the Brogdex System on citrus fruit in the State of Florida.

9

Licensee covenants and agrees to manufacture and install in packing houses of third parties contracting with Licensee

for the use of the Brogdex System machinery and equip-
[fol. 778] ment necessary for the use of said processes, at Licensee's sole cost and expense, in accordance with drawings, patterns, plans and specifications furnished by the Company. Licensee covenants and agrees to furnish said third parties with materials, chemicals, solutions and any other things necessary for the proper application of said processes at its sole cost and expense, and to provide in such contracts for the maintenance, repair and upkeep of said machinery and equipment, it being the intent and purpose of this agreement that the Company shall be under no expense whatsoever in connection with the manufacture, installation or use of said machinery, equipment and processes in the State of Florida. Licensee expressly agrees not to change the design or specifications of said machinery or equipment without the written consent of the Company. Licensee covenants and agrees that it will not alter or change the formulas or vary the strength or proportions of any solutions used in the application of the processes comprising the Brogdex System in packing houses of third parties contracting with Licensee for the use of said system or elsewhere, without the written consent of the Company first had and obtained.

10

Licensee covenants and agrees that so long as this agreement remains in force, it will not manufacture, sell or otherwise deal in machinery or equipment for the treatment of citrus fruit in preparation for marketing by any other processes or methods than those covered by the Brogdex System; Licensee further covenants that it will proceed immediately under this agreement to diligently and continuously further the introduction and commercial use of the Brogdex System on citrus fruits in the State of Florida, and that it will not authorize or permit any use of the Brogdex System or any part thereof except upon terms and conditions ex-
[fol. 779] pressly subject to and in conformity with this present agreement between the Company and Licensee.

11

Licensee covenants and agrees not to infringe nor to aid others in any manner in infringing or making any attack upon the patents, patents applied for, inventions and im-

provements hereinbefore mentioned, nor to give any information relative to any of the same to any persons not associated with the Company; Licensee further agrees to give to the Company without charge any information acquired directly or through its employees or licensees, which might be of value in the improvement of the Brogdex System in any manner, and to convey or cause to be conveyed to the Company all patent rights on inventions included in such information; exclusive license therein for Florida being reserved to Licensee, however, without additional compensation to the Company other than the charges and royalties hereinbefore provided.

12

The Company covenants and agrees that, during the life of this agreement, it will defend, at its own expense, any suit for infringement brought against Licensee or third parties contracting with Licensee for the use of the Brogdex System covered by this agreement. Said Licensee shall give the Company prompt notice in writing of any such suit and the Company shall have the right to conduct the entire defense of such suit.

13

The Company covenants and agrees that during the life of this agreement it will not use patents in any other country to hinder or prevent free exportation of fruit from Florida by the Licensee or its licensees to any country, and the Company will not authorize any of its licensees to do so.

[fol. 780]

14

It is hereby understood and agreed between the parties hereto that nothing in this contract contained shall be construed to impair the right of the Company to carry out any and all contracts hitherto made by the Company with third parties in the State of Florida for the use of its processes, or either of them.

15

It is expressly understood and agreed that the Company does not guarantee the validity of any United States letters patent it may now or hereafer own in connection with the Brogdex System, and in the event said patents or any of

them are held to be invalid by any Court having final jurisdiction of said matters and said Licensee shall thereby be unable to charge or collect royalties for the use of said Brogdex System, or any improvements thereon, then this agreement may be terminated by Licensee and the Company shall not be liable for any loss or damage suffered by Licensee except as herein otherwise provided.

16

It is mutually understood and agreed that if Licensee fails to observe any of the terms or conditions herein set forth, or to fulfill any obligation arising under this agreement, and if such failure be not made good within thirty days after written notice thereof to Licensee, the Company may hold the agreement terminated and all licenses or other rights and privileges granted to Licensee under this agreement shall thereupon cease and determine, unless the arbitrators herein provided for shall otherwise decide, but Licensee shall not, by such determination, be relieved of any obligation or liability under this agreement accrued at the date of such termination.

[fol. 781]

17

The parties hereto agree that if dispute arises between them on any matter covered by this agreement, except as regards the provisions for payment of minimum royalties, the dispute, upon the written request of either party to the other, shall be referred within thirty days thereafter to three arbitrators for consideration and settlement, each party to choose one arbitrator and the two so chosen to select the third, and the decision of said arbitrators, which shall be rendered promptly, shall be binding upon both parties hereto.

18

If, at any time during the term of this contract, the citrus crop of Florida shall be as much as one-fourth or more destroyed by storm, hurricane, frost or other extraordinary force, then the minimum guarantee of royalties for the year of such destruction of fruit shall be reduced in proportion to the part of said citrus crop so destroyed.

19

Licensee hereby covenants and agrees to provide in all contracts with third parties, for the use of said Brogdex System in the State of Florida, that each standard packed box of fruit treated by the Brogdex System shall bear or contain a notice in the words and figures following:

Notice

This fruit, and the process by which it has been rendered resistant to blue mold decay, is protected by United States Patent No. 1,529,461. Other patents pending. Packers who are licensed under said patent display this notice on their fruit. Infringers will be held to strict accountability.

Trade Marks: "Brogdex" "Brogdex"

Brogdex Company, Los Angeles, California.

[fol. 782]

20

Licensee hereby covenants and agres to submit to the Company for its approval any form of contract prepared by the Licensee to be offered to third parties desirous of contracting with Licensee for the use of the Brogdex System.

21

It is mutually understood and agreed between the parties hereto that, subsequent to March 10, 1925, the date of the issuance of United States letters patent No. 1,529,461, third parties in the State of Florida have been infringing upon the claims of said patent by the unlicensed use of borax in treating fresh citrus fruit and by selling citrus fruit so treated. The Company intends to prosecute and collect royalties and damages against such third parties for all infringements, both prior and subsequent to the effective date of this agreement. It is hereby mutually understood and agreed that the Company shall be entitled to all royalties and damages collected against third parties in Florida for infringements occurring prior to the effective date of this agreement, and as to all royalties and damages collected against third parties in Florida for infringements subse-

quent to the effective date of this agreement, the parties hereto agree that each party shall receive one-half of all amounts so collected; provided, however, that the Company shall first be entitled to deduct from each amount so collected any and all costs and expenses, including attorney's fees, incurred by the Company, in making such collection, as well as the proportionate share of any and all other costs and expenses, including attorney's fees, incurred by the Company in establishing the validity of its patents.

22

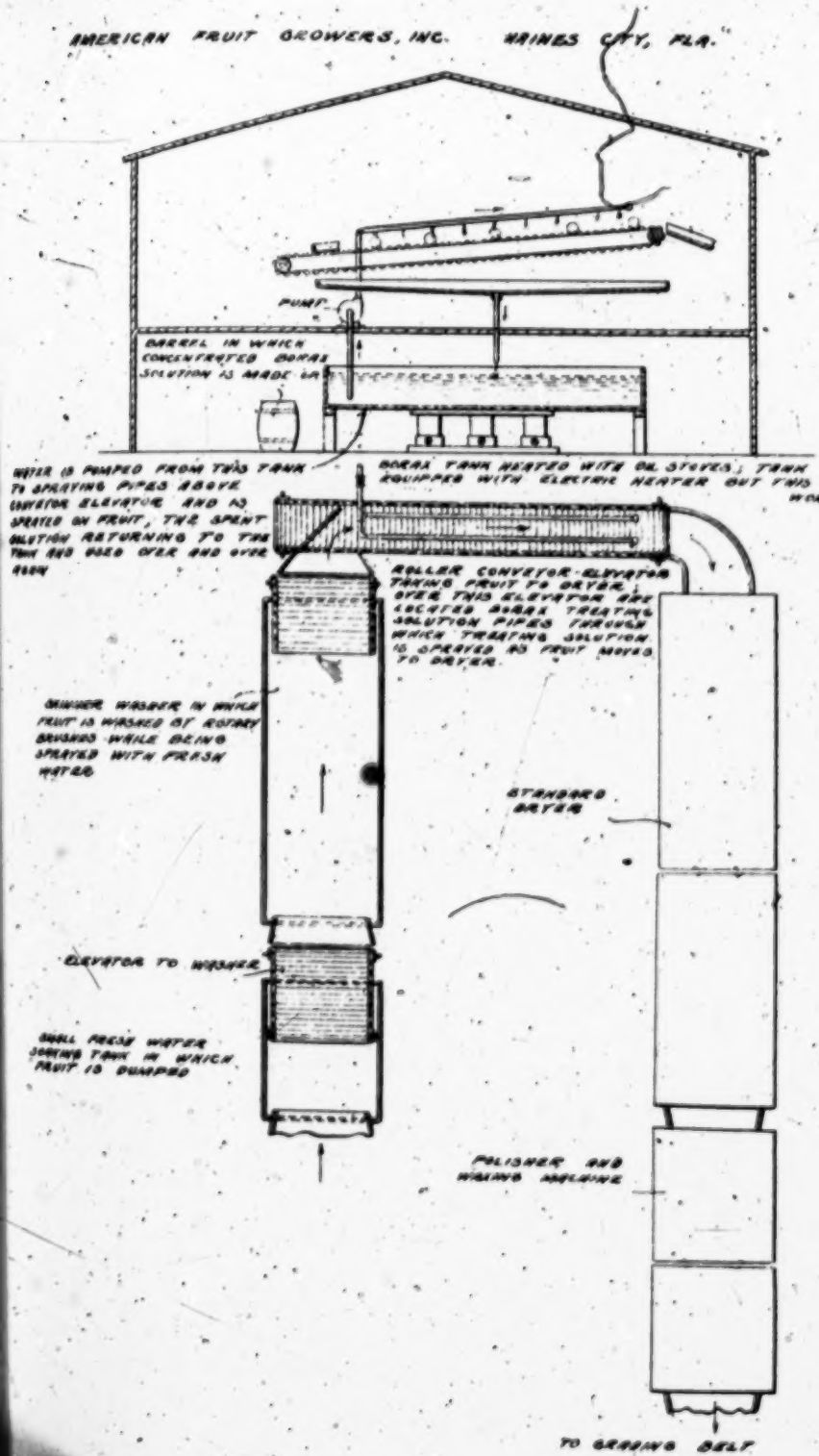
All the terms, provisions, premises and stipulations herein contained shall inure to the benefit of and be binding upon the parties hereto, their successors, assigns and [fols. 783 & 784] legal representatives, until the end of the term of the last patent to be granted in the United States embodying the subject matter of this agreement, unless said agreement be sooner terminated, as herein provided; provided, however, that the rights herein granted to Licensee shall not be hypothecated nor assigned, in whole or in part, without the consent, in writing, of the Company first had and obtained, nor shall the rights herein granted pass or be transferred by operation of law.

In witness whereof, said Brogdex Company has caused this instrument to be signed in its corporate name by its Vice President, thereunto duly authorized, and its corporate seal to be affixed thereto, duly attested to by its Secretary, and said Skinner Machinery Sales Company has caused this instrument to be signed in its corporate name by its President, thereunto duly authorized, and its corporate seal to be affixed thereto, duly attested to by its Secretary, the day and year first above written, said instrument being executed in duplicate.

Brogdex Company, by H. F. Keenan, Vice-President. Attest: W. R. Millar, Secretary. (Seal.) Skinner Machinery Sales Company, by B. C. Skinner, President. Attest: B. W. Skinner, Secretary. (Seal.)

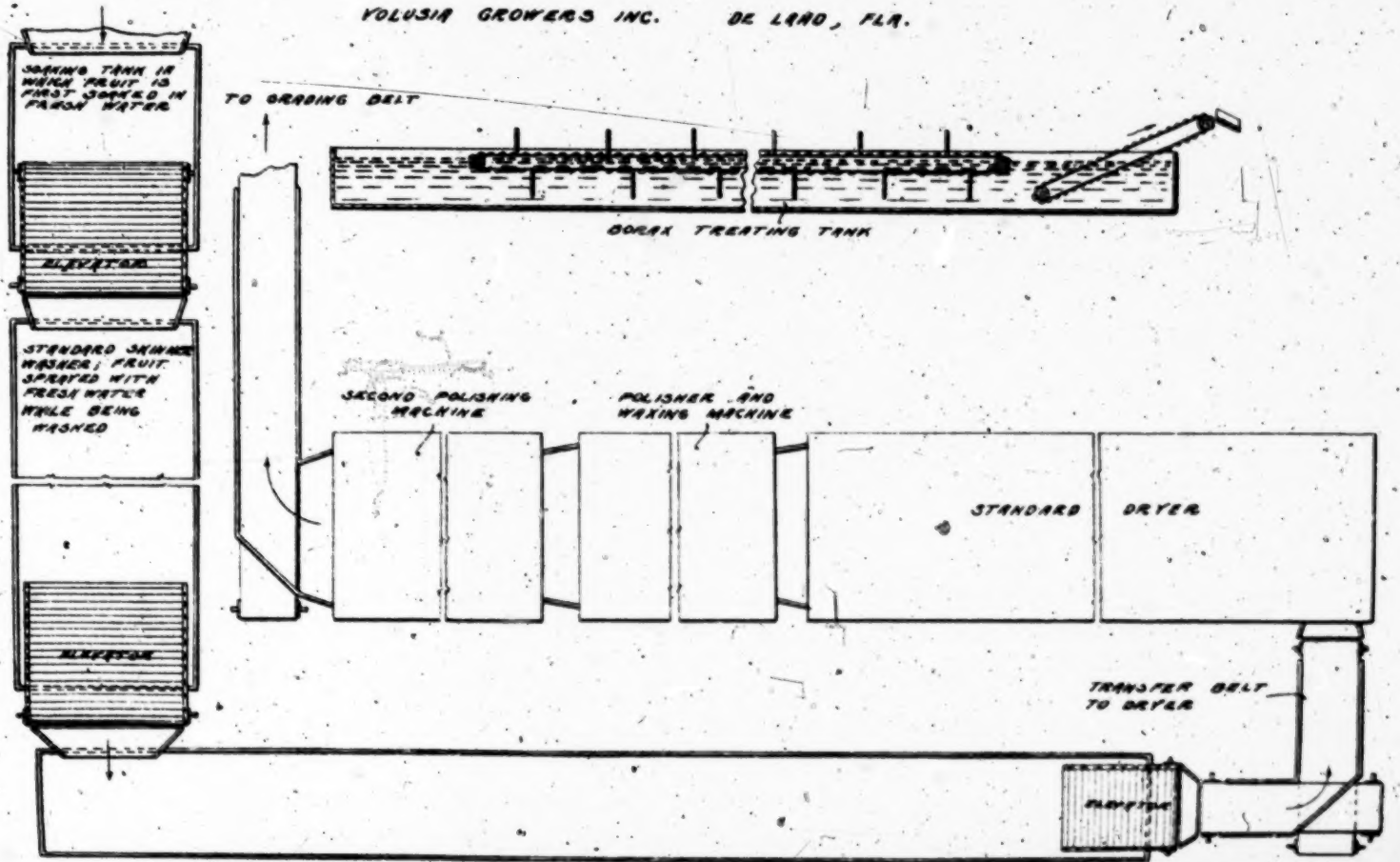
(Here follow diagrams, side folios 785, 786, 787, and 788.)

AMERICAN FRUIT GROWERS, INC. HAINES CITY, FLA.



PLAINTIFF'S EXHIBIT NO. 70.

VOLUSIA GROWERS INC. DE LAND, FLA.

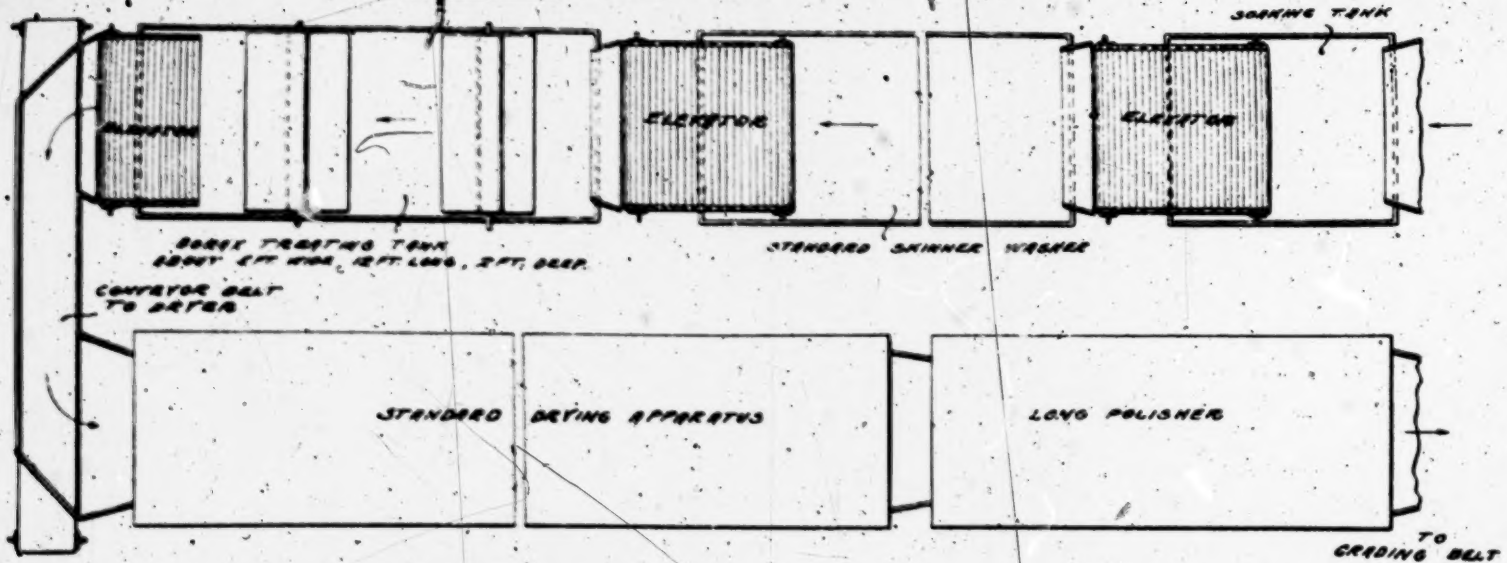


BORAX TREATING TANK ABOUT 30 FT. LONG, 3 FT. WIDE, 18 IN. DEEP. TANK HAS OVERHEAD SUBMERGED LITTLE HEATING PLANT, A KIND OF BACKED-UP OVEN DEVICE LOCATED IN YARD ABOUT 30 FT. FROM TANK, THE SOLUTION BEING CIRCULATED FROM THE TREATING TANK THROUGH THE HEATING DEVICE WITH A LITTLE PUMP.

786

TYPICAL BORAX TREATING SYSTEM IN PACKING HOUSES OF AMERICAN FRUIT GROWERS AT FEW SAVANNA, MIAMI AND COCOA, FLA.

BARREL OR TANK IN WHICH BORAX IS DISSOLVED IN WATER, THIS CONTAINER BEING HEATED WITH ELECTRICITY OR OIL STOVES AND THE STRONG SOLUTION PUT IN THE TREATING TANK.



TWO ROTARY PADDLE WHEEL SUBMERGERS ACROSS TREATING TANK

BORAX TREATING TANK

PLAINTIFF'S EXHIBIT NO. 71.

787 - 788

[fol. 789] PLAINTIFFS' EXHIBIT No. 72

License Agreement for Use of Brogdite and Brogdex Between Skinner Machinery Sales Co., Dunedin, Florida, and ——, ——, Florida.

Date: ——.

Expires: ——.

License Agreement

This agreement, made and entered into at Dunedin, Florida, this 24th day of June, 1926, by and between Skinner Machinery Sales Company, a corporation of Florida, having a place of business at Dunedin, Florida, hereinafter called Licensor, party of the first part, and Brockett & Parrish of Titusville, Florida, hereinafter designated Licensee, party of the second part,

Witnesseth:

Whereas, licensor holds an exclusive license for the State of Florida, with sub-licensing rights from Brogdex Company, of Los Angeles, California, a corporation of Florida, under United States Letters Patent No. 1,529,461, dated March 10, 1925, and pending applications for patent, all relating to treatment of citrus fruit for retarding decay, arising from blue mold development and other causes, to which such fruit may be subject, said treatment being known as "Brogdite," and also under certain other pending applications for patent all relating to treatment of citrus fruit with waxy preservative coating, preparatory to marketing, for improving the appearance of the fruit and retarding shrinkage and withering thereof, which latter treatment is known as "Brogdex," both treatments, together [fol. 790] with the apparatus employed in applying them, being sometimes referred to collectively hereinafter as "Brogdex System"; and

Whereas, licensee is engaged in the business of packing citrus fruit and has a packing house located at Mims, Florida, and is desirous of obtaining the right and license to treat fruit in accordance with the Brogdite and Brogdex treatments aforesaid,

Now, therefore, be it known, that for and in consideration of One Dollar ($1.00) by licensee to licensor paid, receipt of which is hereby acknowledged, and for and in consideration of the covenants and agreements hereinafter

set forth and the faithful performance of same, including payment by licensee to licensor of all moneys as and when due under the terms hereof, the parties hereto have agreed and do hereby agree as follows:

1. Subject to the terms and conditions hereinafter set forth, licensor hereby licenses and empowers licensee to use, from the date hereof until termination of the agreement as hereinafter provided, at its packing house, located at Mims, Florida, and not elsewhere, and for the treatment of citrus fruits and no other fruit or vegetable, the aforesaid methods or processes known by the trade names Brogdite and Brogdex, respectively, and to use the following machinery:

1 Brogdite soaking tank with timer belt.
1 Brogdite washer, 2 runway.
1 Brogdex polisher, 2 runway.
1 Heating plant complete with fuel oil burner and 500 gallon fuel oil tank.

This equipment to be delivered and installed in the house of Brockett & Parrish at Mims, Fla.

Said machinery covered by lease of even date herewith.

2. Licensor agrees to make any and all such alterations, removals or changes in the equipment and machinery now in use in said packing house of licensee as may be necessary [fol. 791] to install all and adequate machinery and equipment necessary for the application of Brogdite and Brogdex, said machinery and equipment together with all materials required for use therewith, to be of sufficient capacity and amount to handle only the present total tonnage and output of said packing house, which total tonnage and output is agreed to be Three carloads per day of ten hours, or an estimated annual output of 50 thousand boxes per season and licensor agrees to use its best efforts to complete said installation within a reasonable time after execution and delivery of this agreement and receipt from licensee of written request to make the installation hereinabove designated as machinery and equipment for the agreed capacity of said packing house. Licensor will install said equipment in said packing house and will operate said machinery and equipment during the trial tests. Licensor will also supervise the operation of said machinery

and equipment during instruction of employees of licensee in the use and operation thereof.

3. During the life of this agreement, licensor will, without cost to licensee other than the license fees or royalties hereinafter specified to be paid, furnish licensee all materials, other than water, constituting the proper formulas for Brogdite and Brogdex, and will maintain said machinery and equipment in good repair, the expense of any and all changes, alterations, repairs and replacements of parts of said machinery and equipment to be borne by licensor.

4. Licensee will furnish all necessary power for operating said machinery and equipment, and all necessary electric current for heating Brogdex apparatus, and all necessary steam or other medium for heating Brogdite apparatus to proper temperature to be designated by licensor

5. It is agreed that the correcting of defects in said equipment by repair or replacement by licensor shall constitute a fulfillment of all obligation to licensee regarding said equipment: this agreement to replace and repair being in [fol. 792] lieu of all warranties not expressly made a part of this contract. Licensor shall not be held responsible for any loss, damage, detention or delay in connection with the shipment of citrus fruit from said packing house arising out of or resulting from the inability to use said equipment while necessary repairs are being made.

6. All machinery and equipment furnished to licensee by licensor under this contract is only leased by licensor to licensee and shall remain personal property, and the title and ownership thereof shall be and remain solely in licensor; and upon termination of this agreement said machinery and equipment may be removed from said packing house by licensor immediately or within thirty (30) days after such termination, at licensor's option.

7. Except as herein otherwise provided, said machinery and equipment shall be operated and said processes shall be applied by licensee and its employees.

8. Licensee agrees to pay licensor on or before Thursday of each week, at licensor's place of business aforesaid, a license fee or royalty of Six cents per standard box of one and three-fifths (1 3-5) bushels of citrus fruit of all grades

above culls run through said packing house and treated with said processes, or either of them, during the next preceding week.

9. It is understood and agreed that the license fee or royalty payments hereinabove provided for shall not commence until the installation of said machinery and equipment in said packing house, as hereinabove provided, is complete and in operating condition; provided, that if licensee should desire to use Brogdite before the installation of equipment for applying Brogdex is complete, licensee may commence the use of Brogdite as soon as the equipment therefor is completely installed in operating condition, and in that case the license fee or royalty payments hereinabove provided shall thereupon commence immediately.

[fol. 793] 10. It is hereby understood and agreed that, upon receipt of notice from licensor that the machinery and equipment to be furnished the licensee under this contract is ready for delivery, licensee will thereupon enter into a lease agreement with licensor and will pay to the licensor the sum of Sixteen Hundred dollars ($1,600.00) as part payment of the rental provided for in said lease agreement, and shall at the same time give licensor a promissory note for the balance of the rental due under said lease agreement, said lease agreement and note to be in the form hereunto annexed and designated as Exhibit A.

11. It is mutually agreed that wherever the word "cull" is used in this agreement it shall mean all fruit which is not shipped or sold and/or which is destroyed or dumped.

12. In the event that fruit treated under this agreement is packed in other than standard boxes, then the license fee or royalty payments due shall be at the same rate for each one and three-fifths (1 3-5) bushels as above specified for standard boxes.

13. During the life of this agreement, licensee agrees to keep an accurate record of the number of standard boxes of citrus fruit of all grades above culls run through said packing house and treated by said process, or either of them, and shall furnish to licensor a statement on or before Thursday of each week under oath, disclosing the exact number of standard boxes of citrus fruit of all kinds and

of all grades above culls run through said packing house and treated by said processes, or either of them, during the next preceding week; and said records of licensee shall be available for inspection by a representative of licensor at all reasonable times.

14. Licensor will supply licensee, without charge, with suitable labels or rubber stamps bearing the trade names Brogdex or Brogdite or Brogdex System, and containing appropriate notice to the public of the fact that the fruit contained in the package has been packed under license [fol. 794] and designating such patent or patents as would be infringed by unauthorized use of the treating processes employed, or either of them. Licensee hereby agrees to place said labels or to impress said stamps on or in all boxes of citrus fruit graded to any standard above culls treated under this agreement; provided, however, that the use of the names Brogdite or Brogdex on boxes of fruit of any grade lower than standard grades above culls, or upon unsound fruit of any grade, or upon fruit not treated with Brogdite or Brogdex, is hereby expressly prohibited. In the event that licensor feels the grade of fruit being shipped by licensee is of such inferior quality that the reputation of Brogdite or Brogdex is liable to be injured thereby, licensor may through its representative order said labels or stamped impressions to be left out of or off of said boxes, and licensee agrees to comply with such order.

15. In the event licensee is unable during any period in the life of the agreement to use the machinery, equipment, and process which are the subject matter of this agreement, by reason of any defect in said machinery or equipment for which licensor is responsible or by reason of any failure on the part of licensor to furnish the materials referred to in Paragraphs 2 and 3 hereof, for which licensor is responsible, subject to the provisions in Paragraphs 4, 5, 6 and 7 hereof, no license fees or royalties shall be paid by licensee for fruit that is run through said packing house of licensee during such period without being treated by said processes, or either of them; provided, however, that in such event it shall be the duty of licensee immediately to notify licensor of any such defect in machinery or equipment or delay in furnishing materials or any other cause rendering it impossible to use said machinery, equipment and processes;

and licensee shall not be relieved from payment of license fees or royalties during said period unless at the time of giving such notice he immediately discontinues the use of both Brogdite and Brogdex.

[fol. 795] 16a. "Licensor agrees that, during the life of this agreement, it will defend, without expense to licensee, any suit for infringement brought against licensee for the use of the Brogdex System covered by this agreement; provided, however, that licensee must promptly notify licensor, in writing of any such suit and shall forward to licensor, immediately upon receipt thereof, all papers served upon licensee in connection with such suit; provided further that in any case licensor shall have the exclusive right to conduct the entire defense of such suit."

16b. In the event that licensee shall be prevented by legal process arising out of such infringment suit referred to in Paragraph 16a from using said machinery, equipment and processes of Brogdex System in its packing house, licensee shall not be required to pay the license fee or royalties herein provided upon fruit run through said packing house during the period when licensee is so prevented from such use; provided, however, that licensee shall not be entitled to claim or recover any damages from licensor by reason of being so prevented from using said machinery, equipment and processes.

17. Licensee hereby acknowledges the title of said Brogdex Company to all patent rights in said processes, materials, apparatus, and equipments, and any improvements, alterations or changes in same that may be made use of by Licensee during the life of this agreement, and expressly agrees not to set up any claim assailing or tending to assail the title of said Brogdex Company. Licensee further acknowledges the validity of the aforesaid Letters Patent No. 1,529,461 and the validity of such other Letters Patent as may be granted upon the pending applications aforesaid. Licensee also covenants and agrees not to infringe or to aid others in any manner in infringing or in making any attack upon the patents, patents applied for, inventions and improvements hereinbefore mentioned, nor to give any information relative to any of the same to any persons not asso-
[fol. 796] ciated with Licensor or with Brogdex Company.

Licensee further agrees to give licensor without charge any information acquired directly through its employees or licensees which might be of value in the improvements of the Brogdex System in any manner, and to convey or cause to be conveyed to said Brogdex Company, all patent rights on inventions, improvements or discoveries that may be included in such information. Licensee being entitled however, to use of the same, subject to the provisions of this agreement, without additional compensation to Licensor other than the licensee fees or royalties hereinbefore provided.

18. It is mutually understood and agreed that it is essential to the successful application and use of the Brogdite and Brogdex processes that the treating solutions and materials be compounded in the proportions and manner described in the instructions to be given licensee by licensor from time to time, and that said solutions, materials and processes be applied and used strictly in accordance with said instructions; and licensee hereby expressly agrees to follow and abide by said instructions.

19. Licensee hereby agrees that a representative of licensor shall have access at all reasonable times during the life of this agreement to the packing house of licensee for the purpose of determining that said Brogdite and Brogdex processes are being used in accordance with the instructions of licensor. In the event that such representative shall at any time find upon inspection of the operation of said packing house that licensee is not compounding said solutions and materials and/or applying or using said processes or either of them, in accordance with the instructions of licensor last given, licensor shall so report to the manager of said packing house and licensee shall thereupon cease to apply Brogdite process and/or Brogdex process in any manner other than embodied in such instructions, unless licensor [fol. 797] shall have approved in writing the modification by licensee of the instructions last given by licensor.

20. During the life of this agreement, licensee agrees to treat with the Brogdite process all citrus fruit of grades higher than culls that is run through said packing house and, provided the condition of the color of said citrus fruit warrants the same, licensee may at his option also treat all such

citrus fruit with the Brogdex process; and the licensee fees or royalties payable under Paragraph 8 hereof are based upon the conclusive presumption that the Brogdite process has been applied to all fruit of grades higher than culls run through said packing house during the life of this agreement, except as herein otherwise provided.

21. Licensee hereby expressly agrees that the machinery, equipment and processes herein mentioned shall not be used in connection with any process for retarding decay or shrinkage or withering of fruit other than the processes for which a license is herein granted, or for any other purposes not covered by this agreement.

22. It is hereby understood and agreed between the parties hereto that licensor assumes no responsibility or liability for loss or damage of any kind to licensee arising out of or resulting from the installation or use of said machinery and equipment or said processes, or either of them, except as herein otherwise expressly provided.

23. Licensee agrees to use due care and diligence in maintaining its packing house machinery in such condition that citrus fruit run through said packing house will not be mechanically injured. Licensee further agrees that if attention is called to defects in the machinery of said packing house likely to cause or causing mechanical injury to citrus fruit run over said machinery, licensee will use all reasonable efforts to correct such defects to the end that mechanical injury to citrus fruit run over said machinery shall be reduced to a minimum.

24. Time is of the essence of this contract, and should the licensee fail to observe any of the conditions herein set forth [fol. 798] to fulfill any of the obligations arising under this license agreement, written notice of such default shall be given to licensee by a letter mailed to licensee at its principal place of business at Titusville, Florida, and in the event such default is not cured within ten (10) days of receipt of said notice, licensor may at its option hold this agreement terminated and all rights and privileges of licensee under this agreement, upon exercise of said option by licensee, shall cease and determine, but licensee shall not thereby be relieved from any obligation or liability under this agree-

ment accrued at the date of such termination. Any waiver by licensor of the right to terminate this agreement as above set forth shall not be construed as a waiver of said right upon a further breach of the conditions or obligations of this agreement by licensee.

25. Unless sooner terminated as herein provided, the duration or life of this agreement shall be Three years from the date first hereinabove written.

26. It is expressly understood and agreed that this agreement constitutes the sole contract and agreement between the parties hereto concerning the matters herein stated, and that there is no verbal contract or understanding modifying the same.

27. This agreement shall be binding upon and inure to the benefit of licensor, its successors and assigns, and shall be binding upon and inure to the benefit of licensee and its bona fide successor or successors in business; but the license rights granted under this agreement are not assignable by licensee except with the written consent of licensor. This contract does not go into effect until accepted at Dunedin, Florida, by a duly authorized officer of Skinner Machinery Sales Company.

In witness whereof the parties hereto have caused this agreement to be executed in duplicate the date first hereinabove written, each by its proper officers thereunto duly authorized.

[fol. 799] Accepted by Skinner Machinery Sales Company at Dunedin, Florida, on the 18th day of Aug., 1926.

Skinner Machinery Sales Company, by B. C. Skinner, President. Witness as to Skinner Machinery Sales Co.: E. N. Maull, E. E. Craunell. Brockett & Parrish, by F. J. Parrish, President. Witness as to Licensee: E. N. Maull, E. E. Craunell.

PLAINTIFFS' EXHIBIT No. 73

Lease No. 5

Lease

COUNTY OF BREVARD,
City, Titusville:

Date: June 24th, 1925.

To Skinner Machinery Sales Company, a corporation organized and existing under the laws of the State of Florida, Lessor, the undersigned Lessee hereby leases from you for the term of Three years from the date of delivery thereof the following described property:

1 Brogdite soaking tank with timer belt.
1 Brogdite washer, 2 runway.
1 Brogdex polisher, 2 runway.
1 Heating plant complete with fuel oil burner and fuel oil tank, 500 gall.

This equipment to be delivered and installed in the house of Brockett & Parrish at Mims, Fla., hereinafter referred to as "machinery," for which the Lessee shall pay you as rental for said term the sum of $6,000.00 as follows: $1,600.00 on the date hereof and the balance to be paid in 16 equal [fol. 800] payments of $275.00 each, on or before the following dates: Dec. 15, 1926, Jan. 15, 1927, Feb. 15, 1927, Mar. 15, 1927, Apr. 15, 1927, May 15, 1927, June 15, 1927, Jul. 15, 1927, Dec. 15, 1927, Jan. 15, 1928, Feb. 15, 1928, Mar. 15, 1928, Apr. 15, 1928, May 15, 1928, June 15, 1928, Ju. 15, 1928, as evidenced by one certain promissory note executed by the Lessee dated evenly herewith, made payable to your order at the Peoples Bank, Clearwater, Florida, or at any other place you may hereafter designate in writing, together with interest after maturity at the highest lawful rate. Said note may be detached herefrom for negotiation and when so detached shall be a separate and distinct instrument herefrom.

It is mutually understood that this machinery is to be used solely for the application of the Brogdex System of treating fruit, and that a separate license agreement shall be made providing for royalty payments of six cents per box, which are separate and apart from the rental provided

for under this contract, and that there is no connection between the Lease and the royalty or lincense contract except that this machinery is rented specifically for use solely under license, as provided in said separate license agreement of even date herewith.

The Lessor hereby agrees to keep in repair said machinery, making such replacements of brushes and other working parts as may be necessary to keep the machinery in good operating condition, but is not required under this Lease to make good any ordinary depreciation, except to the extent necessary to keep the machinery in good and proper operating condition.

Title and ownership of said machinery are and shall remain vested in you or your successors or assigns during said term, and shall be subject to your order upon the termination of this Lease and no delay in giving orders relative thereto shall be considered a waiver of your rights hereunder.

[fol. 801] The Lessee agrees that neither the loss, injury or destruction of the machinery during the said term, nor the giving of renewals or extensions of said note, shall, in any manner, release Lessee from the payment of the rent for the full term herein above mentioned, nor from the performance of any of the conditions herein contained.

And it is further agreed that if any installment of rent reserved hereby shall become due and remain unpaid in whole or in part, or if fire insurance is not kept paid as hereinafter agreed, or if said machinery is removed or attempted to be removed, or is otherwise disposed of or attempted to be disposed of, or if Lessee shall sell or encumber, or shall attempt to sell or encumber, said machinery, or shall suffer the same to become encumbered by judgment or other lien or other legal process against said Lessee, or if the same shall be misused or abused during the said term, or whenever you shall deem yourself insecure, or should any surety company or any bond guaranteeing performance of any obligations hereunder or indemnifying the holder of said note against loss through conversion or otherwise desire to withdraw from said bond, the entire unpaid balance of said rent, notwithstanding the tenor and effect of the said note, shall at once become due and payable forthwith, and you may, without previous notice or demand, and without legal process, enter any premises where said machinery is, or

is supposed by you to be, and take possession thereof, and all payments theretofore made shall be retained by you for account of the use of said machinery and for any depreciation in the value thereof by reason of such use and for any loss or damage by you sustained by reason of any act or default contrary to any agreement herein contained; and said machinery may be again leased by you, and the rent received therefor for and during the balance of Lessee's said term or any part thereof less the expenses and costs of tak-
[fol. 802] ing, removing and holding, and again leasing said machinery (including a reasonable attorney's fee), shall be credited upon account of any unpaid rent reserved hereunder, and of any indebtedness incurred by Lessee hereunder, and should the rent upon such reletting be insufficient to pay all of such indebtedness to you hereunder, Lessee agrees to pay the balance forthwith. This remedy, like all others herein contained, shall be merely cumulative, and is given in addition to any and all other remedies afforded by law and the use of one, or more, shall not exclude the use of the other, or others, unless and until the obligations are paid in full.

Lessee specifically agrees to carry fire insurance at his expense in favor of the Lessor for the highest insurable value of said machinery, the policies and all renewals thereof to be deposited by said Lessee with said Lessor. Said machinery to be delivered to the order of the Lessor upon the termination of this Lease in as good repair as the same is now in, the ordinary and usual wear excepted, it being the intention that it shall be delivered back to the Lessor in good running order.

It is understood and agreed that this Lease constitutes the sole contract and agreement between the parties hereto concerning the matters herein stated, and that there is no verbal contract or understanding modifying the same or in any way varying the terms thereof, and that no person, or persons, is authorized by said Lessor to vary said terms either verbally or otherwise.

All of the terms thereof inure to the benefit of your successors and assigns but this Lease shall not be assignable by the Lessee without the written consent of the Lessor. No waiver or indulgence of any default hereunder shall operate as a waiver of subsequent defaults.

[fol. 803] This Lease is entered into the day and year first above written and the Lessee hereby acknowledges receipt of a true copy hereof.

Accepted Aug. 18, 1926.

Skinner Machinery Sales Company, by B. C. Skinner, President. Attest: B. W. Skinner, Secretary. (Seal.) Signed, sealed and delivered in the presence of E. N. Maull, E. E. Craunell. Brockett & Parrish by F. J. Parrish, President, Brevard County, Florida. (Seal.) Witnesses as to lessee's signatures: E. N. Maull, E. E. Craunell.

STATE OF FLORIDA,
County of ——:

On this day appeared before me B. C. Skinner and B. W. Skinner as President and Secretary of Skinner Machinery Sales Company who acknowledged that they executed the foregoing instrument for and on behalf of said company as its President and Secretary, they being thereunto duly authorized.

Witness my hand and official seal this 21st day of Aug., 1926.

Nellie A. Cushing, Notary Public, State of Florida at Large. My Commission Expires Sept. 4, 1926. (Seal.)

$4,400.00. Titusville, Florida, June 24th, 1926.

After date, I, We, or either of us, for value received, promise to pay to the order of Skinner Machinery Sales [fol. 804] Company, in 16 equal installments of $275.00 each, payable on or before the following dates: Dec. 15, 1926, Jan. 15, 1927, Feb. 15, 1927, Mar. 15, 1927, Apr. 15, 1927, May 15, 1927, Jun. 15, 1927, Jul. 15, 1927, Dec. 15, 1927, Jan. 15, 1928, Feb. 15, 1928, Mar. 15, 1928, Apr. 15, 1928, May 15, 1928, Jun. 15, 1928, Jul. 15, 1928—Four Thousand Four Hundred Dollars with interest after maturity at the highest lawful rate, payable at the Peoples Bank, Clearwater, Florida, or at such other place as the payee or legal holder hereof may hereafter designate.

Now, should it become necessary to collect this note through an attorney, either of us, whether maker, security

or endorser on this note hereby agrees to pay all costs of such collection, including a reasonable attorney's fee.

The drawers and endorsers severally waive presentment for payment, protest and notice of protest and non-payment of this note, and also in case of suit waive their statutory right of being sued in the county of their residence.

Brocket & Parrish, by F. J. Parrish.

1377

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

SCIENTIFIC PAPERS OF THE BUREAU OF STANDARDS, No. 495
[Part of Vol. 19]

A RADIOMETRIC INVESTIGATION OF THE GERMICIDAL ACTION OF ULTRA-VIOLET RADIATION

BY

W. W. COBLENTZ, Physicist
Bureau of Standards
H. R. FULTON, Pathologist
Bureau of Plant Industry

December 10, 1924

PRICE, 20 CENTS
$1.25 PER VOLUME ON SUBSCRIPTION
Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1924

1878

1279

A RADIOMETRIC INVESTIGATION OF THE GERMICIDAL ACTION OF ULTRA-VIOLET RADIATION

By W. W. Coblentz and H. R. Fulton

ABSTRACT

In the present investigation an attempt is made to determine the energy relations involved in abiotic action, thus placing the results upon a radiometric basis. By means of screens of mica, and of glass, successive portions of the ultra-violet spectrum are eliminated and the effects upon the resulting germicidal action established. The novelty in the present investigation consisted in making an application of the discovery that mica has a well-defined absorption band at about 200 mμ. A small variation in thickness of the mica screen produces a large variation in transmission in this spectral region relative to the rest of the spectrum, thereby permitting an increase in the intensity of the radiation stimulus of these wave lengths, while other conditions remained practically constant.

The effects of preexposure of the culture medium upon subsequent inoculation were investigated, and found negligible for the intensities and the time of exposure used in this investigation.

The paper gives data on (1) the effect of continuous and of intermittent exposure; (2) the spectral range of, as well as the effect of the intensity of the radiation stimulus upon abiotic action; and (3) the energy required to kill a bacterium.

For low intensities a stimulation of bacterial growth may possibly occur, which is a question requiring further investigation.

CONTENTS

	Page
I. Introduction	642
II. Experimental procedure	649
1. General arrangement of the ultra-violet radiator	649
2. Special energy distribution of the mercury arc	651
3. The transmission screens	652
(a) Data on the transmission screens	654
4. Calibration of the radiation intensity	655
5. Spectral transmission of some culture media and amino acids	658
(a) Water	659
(b) Bouillon	660
(c) Peptone	660
(d) Tyrosin and phenylalanin	661
6. Biological material and methods	661
III. Experimental data	662
1. Effect of ultra-violet light upon the culture medium	662
2. Death of bacteria in distilled water	664
3. Effect of continuous and intermittent exposure	665

1380

III. Experimental data—Continued. Page
4. Spectral range of abiotic action 666
(a) The long wave-length limit of abiotic action 669
1. Screens Nos. 6 and 7 669
2. Screens Nos. 8 and Noviol 670
3. Screens Nos. 7 and 8 670
4. Screens Nos. 8 and G586 671
(b) Shielding action of the culture medium 672
(c) Abiotic action through screens of solutions of amino acids 673
5. Effect of intensity upon abiotic action 674
6. The energy required to kill a bacterium 676
(a) Abiotic action. No screen 677
(b) Abiotic action. Mica screen No. 2 677
IV. Summary 678

I. INTRODUCTION

Frequent requests are received for information on the photochemical and abiotic action of ultra-violet rays in dye fading, water sterilization, injurious effects upon the eyes, etc.

These questions have been the subject of numerous investigations from the standpoint of biologists, chemists, and physicists. A perusal of the literature on the subject shows, in many cases, incompleteness of experimental procedure, and sometimes flagrant inconsistencies in the conclusions.

The present investigation had its beginning in the strictly utilitarian question of the practicability of exposing fruit (for example, oranges) to ultra-violet light in order to destroy the mold spores thereon, before wrapping and packing, thus reducing the loss caused by decay, which is of great importance to the producer, vender, and consumer. The investigation was extended to the general subject of germicidal action as affected by the wave length and the intensity of, as well as the method of exposure (whether continuous or intermittent) to, the exciting light.

While no claim can be made for completeness, the results thus far obtained serve to clear up several mooted questions, as well as to show some interesting relations between chemical and physical agencies which produce germicidal effects.

Since, as already stated, the literature is replete with investigations on the germicidal action of ultra-violet light,[1] it seems sufficient to refer only to some of the papers which are pertinent to

[1] See a bibliography of 32 references on water sterilization in a paper by Houghton and Davis, Amer. Jour. of Public Health, 4, p. 214; 1914; also a book just issued by M. Luckiesh on ultra-violet radiation, its properties, production, measurement, and applications. A paper on the uses and possibilities of ultra-violet light, by Krueger, Gen. Elect. Rev., 24, p. 316, 1921; gives a discussion and an extensive bibliography of various recent researches involving the application of ultra-violet radiation. A very complete bibliography of the physiological and biological effects of ultra-violet radiation is given in a paper by E. Mayer, Amer. Rev. of Tuberculosis, 5, p. 75; 1921.

the questions discussed in the present communication. From the experimental data at hand it appears that the wave-length limit of germicidal action, as well as the abiotic action upon living tissue in general, is rather indefinite.

Two methods, in general, have been used in attacking this problem: (1) By exposure of the material covered with screens which absorb certain wave lengths of the ultra-violet and (2) by exposure of the material to the ultra-violet spectrum produced by a quartz spectrograph.

In the experiments of Henri [2] and his collaborators using the mercury-vapor arc in quartz, also the spark between electrodes of cadmium and of magnesium as sources of radiation, filtered through transmission screens of glass, and of celluloid, which were placed over the material investigated, it was found that the destructive action of the light increased as the wave length decreased. The bactericidal action of rays longer than 305 mμ was extremely slow, requiring three to five hours to sterilize an emulsion of *Bacillus coli* instead of only 15 to 20 seconds when using wave lengths shorter than 305 mμ. They found that the rate of killing is different for different kinds of bacteria; also that the germicidal action decreases more rapidly than the inverse square of the distance from the source. In other words, as will be shown in the present paper, the killing action is proportionately much slower for low than for high intensities.

Similar investigations by Verhoeff and Bell [3] on eye media, show that the abiotic action on living tissue is confined practically to wave lengths shorter than 305 mμ. Moreover, within wide limits, discontinuous exposures to abiotic rays had the same total effect as a continuous exposure of the same total length of time. In other words, using intensities above a certain energy level, the effect of the abiotic action was found to be cumulative in its injurious effect upon the eye.

The action of the ultra-violet rays of very short wave lengths, known as the Schumann rays (λλ 125 to 170 mμ) upon living organisms has been studied by Bovie.[4] He made no radiometric measurements. However, it is fairly well established that the Schumann [5] radiation of the hydrogen discharge tube is of low intensity. Nevertheless, he found the Schumann rays very

[2] Cernovodeanu and Henri, Compt. Rend., 135, p. 915; 1902; 150, pp. 52 and 549; 1910; Henri, Compt. Rend., 155, p. 315; 1912.
[3] Verhoeff and Bell, Proc. Amer. Acad. Arts and Sci., 51, p. 640; 1916. (See extensive bibliography.
[4] Bovie, Botanical Gazette, 61, p. 1; 1916. (Good bibliography.)
[5] Lyman, Ann. der Phys. (4), 18, p. 909; 1904.

1382

destructive to protoplasm. The action of the light is shown to be exerted directly upon the organism and not indirectly through the formation of some toxic substance in the medium. But it is necessary for the rays to penetrate the cell wall of the organism. For this reason he selected organisms having thin, transparent cell walls. Fungus spores, with brown or tan coloring matter in their cell walls, even though the walls were thin, were not killed by a prolonged exposure to the Schumann rays.

The window of the vacuum discharge tube containing hydrogen, was of fluorite, which is transparent to wave lengths longer than 125 mμ.[6] Interposing a rock-salt screen which is opaque to radiation of wave lengths less than 170 mμ, Bovie found that, in the Schumann region of the spectrum as in the region of longer wave length (200 to 300 mμ) the destructive action of the light increases as the wave length decreases. The action of the light was 15 to 20 times more destructive when it contained the short waves than when these short rays were filtered out. He concluded that the radiation in the Schumann region is much more destructive than the rays of longer wave length; and that the destructive action of the ultra-violet rays is continued into the Schumann region of the spectrum without changing its character. It is of interest to add that he found that, if the decomposition of the protein molecule is not carried too far, there is a stimulation of the cell. This stimulation phenomenon has been observed by a number of investigators, but apparently has not been given a thorough study. It is, therefore, proposed to include this question in a continuation of the present investigation.

Turning now to some of the experiments with spectrally isolated radiation stimuli we find more discordant and sometimes inconsistent results. Frequently no radiometric measurements were made of the spectral intensities; and in some cases where reference is made to the use of spectral lines having the same intensity no information is given as to the manner in which this was established.

Among the early investigations of the physiological action of spectral radiation upon living tissues is that of Hertel,[7] who used lenses and a prism of quartz to form the spectrum of the light from spark gaps of various metals. The spectral intensities were measured by means of a thermopile. He found that the abiotic action of the light varies directly as the energy and inversely as the wave length.

[6] Lyman, Astrophys. Jour., 25, p. 45; 1907.
[7] Hertel, Zeitschr. f. Allgem. Physiol., 5, pp. 95 and 534; 1905.

Bazzoni [8] has published some experiments on the destruction of bacteria through the action of ultra-violet light. Using isolated emission lines from the mercury arc he found that, after a three-hour exposure, the number of living bacteria (*B. typhosus*) was as follows: Wave length of exciting radiation, 220, 236, and 253 mμ, respectively; number of bacteria remaining 1/80, 1/50, and 1/12, respectively. This shows the very rapid increase in bactericidal action with decrease in wave length. For, as will be shown presently, if it were a question only of the intensity of the exciting radiation (see fig. 2), then the 253 mμ line should have killed the greatest number of bacteria.

Bazzoni observed that the killing effect of the total radiation from the mercury arc is much more rapid than that of the isolated wave lengths. But he seems to have overlooked the fact that some of the wave lengths selected for his experiments are weak radiometrically; also that there is considerable continuous spectrum, so that the effect of a single wave length is insignificant as compared with the combined action of all the rays having germicidal properties. He concluded that the destructive effect of the ultra-violet radiation is in some way dependent on its association with radiation of greater wave length and greater penetrating power.

Instead of taking the view of Bazzoni that the presence of the long wave-length radiation accelerates bactericidal action of the short wave lengths the reverse might be said, viz, a little ultra-violet radiation of short wave lengths mixed with the long wave-length radiation accelerates the bactericidal action of the long wave lengths.

But it is highly probable that this same amount of ultra-violet radiation, acting without the presence of the longer wave lengths, would produce the same bactericidal action as would be obtained with the presence of the longer wave lengths. It is not an easy matter to make the test in this manner. The present investigation, in which increasing amounts of short wave length ultra-violet radiation are added to the radiation stimulus of longer wave lengths, seems to indicate that the bactericidal action is not necessarily associative, but is a function of the wave length and the intensity of the particular lethal radiation used.

An interesting investigation of the germicidal action of ultra-violet radiation and its correlation with selective absorption has

[8] Bazzoni, Amer. Jour. Publ. Health, 4, p. 975; 1914.

been published recently by Browning and Russ.[1] The method employed consisted in coating a glass plate with a thin layer of nutrient agar, painting it with microorganisms, and exposing it in the spectrum of a quartz spectrograph. The source of radiation was an arc of pure tungsten. After exposure and incubation, that part of the plate extending from wave lengths 294 to 238 mμ was found covered with clear lines coinciding with the emission lines which had produced a bactericidal effect.

No data are at hand concerning the spectral energy distribution in the tungsten arc. Hence, nothing can be said regarding the sharp termination of the germicidal action in the short wave lengths, which result seems contrary to general experience, and is probably owing to absorption in the instrument.

Their published photograph of the arc spectrum of tungsten appears weak for wave lengths less than 230 mμ. This is owing, in part, to lack of sensitivity of the photographic plate in this spectral region, and especially to the high absorption in the quartz spectrograph for wave lengths less than 220. mμ. As already stated, no radiometric measurements of the ultra-violet spectral energy distribution of the tungsten arc have been published. Hence, part of the weak germicidal action in the short (less than 210 mμ) wave lengths may be owing to a weak spectral intensity of the arc. For, as mentioned in the above-cited investigation by Bovie, the germicidal action is very marked in the extremely short wave lengths.

Control experiments were made to determine whether the radiation had any effect upon the (uninoculated) agar. No difference was detected in the density of growth of the organisms over the portions of the agar which were irradiated and non-irradiated before inoculation. This is in agreement with the results of the present investigation for the intensities actually used in our work.

The absorption spectrum of the bacterial emulsion was found to extend from 296 to 210 mμ, which is the spectral range of germicidal action. In the present investigation, as will be shown presently, the high absorption of some nutrient media in the ultra-violet prevents bactericidal action in the very short wave lengths.

The spectral range of germicidal action was thought to be different for different organisms, exposed simultaneously. For

[1] Browning and Russ, Archives Radiology and Electrotherapy, 18, p. 85; 1918.

B. coli the range of lethal effect extended from 296 to 220 mμ and for *B. typhosus* it extended from 300 to 210 mμ. For *Staphylococcus pyogenes aureus* the spectral range of greatest germicidal action extended from 296 to 238 mμ.

It was noted by Browning and Russ that the organisms appeared to be stimulated in their growth, in the region of the plate lying between two portions which had been exposed to the ultra-violet spectrum, though they do not attribute it necessarily to scattered radiation. As will be shown presently, such an increase is always observable in the shadowed portion of the Petri dish adjacent to the region exposed to the ultra-violet rays. A possible explanation is that along this edge the unaffected bacteria have a better chance for obtaining nutriment, and hence for better development, than in the more crowded part of the plate. Furthermore, our tests with the water suspensions, for short exposures, show a similar increase in bacteria per cubic centimeter, which may be attributed to erroneous experimental procedure in handling control samples. However, when considered in connection with the above-cited experiments of Bovie, also of Browning and Russ, there is some evidence that organisms are stimulated in growth when exposed to low-intensity ultra-violet radiation. As already mentioned, this is a phenomenon that will be given further study.

Mashimo[14] has published the results of an investigation similar to that of Browning and Russ, but independent of it. As a source of radiation he used the condensed spark spectrum of iron. He exposed the bacteria in the spectrum for various intervals of time up to 40 minutes. He gives an excellent photograph of the incubated plate, upon which the ultra-violet spectrum has left an impression similar to that of a sensitized photographic plate.

The results obtained show that the bactericidal effect of the ultra-violet radiation begins at about 295 mμ, attains its maximum at 275 mμ, and then decreases slowly to 186 mμ, which, as noted elsewhere, is the beginning of atmospheric absorption. This effect seemed to be independent of the nature of the bacteria, and of the culture medium employed.

From tests made on bacteria exposed to the sun with and without glass screens of various thicknesses (1 and 10 mm) intervening, he concluded that the most lethal part of the sunlight having a bactericidal action lies in the ultra-violet region of wave lengths less than 295 mμ.

[14] Mashimo, Mem. College of Sci., Kyoto Imperial Univ., 4, p. 1; 1919.

The slight discrepancy in the results of Browning and Russ and of Mashimo are attributable to experimental difficulties, such, for example, as the difficulty in controlling a metal arc. The results of Mashimo are particularly important in showing that there is no discontinuity in the germicidal action throughout the ultra-violet spectrum, extending into the Schumann region, investigated by Bovie (loc. cit.).

In most of the foregoing investigations the organism was in or upon a nutrient medium, which might have some protective effect from the abiotic rays. Newcomer [11] tried to overcome this by using fresh-water suspensions of the organism (typhoid bacilli) in quartz capillary tubes, which were held in the spectrum produced by a quartz spectrograph. The source of ultra-violet radiation was a condensed iron spark, also sparks of copper and of zinc. The relative intensities in the spectrum were measured photographically, which, however, can not be considered a satisfactory means of estimation of energy distribution. After exposure (of 5 to 10 minutes) the contents of the exposed quartz tubes were plated in melted agar, after which the plates were incubated and counts made. He obtained no killing action for wave lengths greater than about 300 mμ, which no doubt is owing in part to lack of intensity of the light. Exposure to sunlight for 20 minutes produced no effect.

To the foregoing somewhat inconsistent results may be added a very recent investigation of the bactericidal action of spectrally dispersed ultra-violet light,[12] which included also a determination of the absorption spectrum of the bacteria, as well as the effects of temperature and of hydrogen-ion concentration of the culture medium. The culture of *Staphylococcus aureus* was spread upon a plate of nutrient agar and exposed to the spectrum of an iron spark. It was found that the lethal effect of the ultra-violet radiation upon bacteria is greatly accelerated in an acid medium; the velocity of the bactericidal action increased with increase in hydrogen-ion concentration.

It was established that the bactericidal action of the light begins at 350 mμ and extends with increasing intensity to the shortest wave lengths at 185.6 mμ transmitted by the quartz spectrograph. No energy measurements were made. The long wave-length limit of bactericidal action was established by exposing cultures of bacteria to the sun (for three hours) under screens

[11] Newcomer, Jour. Exptal. Medicine, 26, p. 841; 1917.
[12] Bayne-Jones and Van der Lingen, Johns Hopkins Hospital Bull., 34, p. 11; 1923.

of quartz and of glass, including Crook's neutral tint glass, which is opaque to radiation of wave lengths less than about 350 mμ. Nevertheless, some bactericidal action was obtained through this glass.

This is in agreement with the results of the present investigation, in which, as will be shown presently, it was found that radiation of wave lengths 334 to 365 mμ are bactericidal, disproving some of the inconsistent results cited in the foregoing pages.

In concluding this summary it is relevant to add that writers on this subject appropriately point out that the short wave-length limit of the solar spectrum is between 280 and 290 mμ, and hence living organisms are adapted to existence in sunlight. However, the time of exposure must also be considered, so that while the intensity of the solar rays lying between 290 and 305 mμ is extremely small [13] as compared with the mercury arc, it is nevertheless possible to produce germicidal action with sunlight, provided sufficient time is given in making the test.

II. EXPERIMENTAL PROCEDURE

The experimental procedure is not essentially different from that usually employed in investigations of this type. An attempt is made to present the results on a quantitative radiometric basis which seems to be the rational procedure in order to obtain some estimate of the germicidal action of different parts of the spectrum.

1. GENERAL ARRANGEMENT OF THE ULTRA-VIOLET RADIATOR

The mercury arc in an exhausted quartz vessel is a convenient and powerful source of ultra-violet radiation.

In the present investigation use was made of a 110-volt quartz burner, having a mercury cathode and a tungsten anode. The current and voltage of this style of burner are subject to greater fluctuations than the all-mercury type of burner. While, for short exposures (say, one-tenth second) this fluctuation might introduce errors, in previous investigations of the emissive properties of these burners [14] it was found that the average energy input and energy radiated is constant to within the limits of the experimental errors of other factors entering into the problems under investigation.

[13] Coblentz and Kahler, B. S. Sci. Papers, 16, p. 233; 1920 (No. 378).
[14] B. S. Sci. Papers, 15, p. 1; 1918; 16, p. 233; 1920 (Nos. 330 and 378).

The top, sides, and ends of this lamp were permanently inclosed in a metal box, as illustrated in Figure 1. The bottom of this box consisted of a shield (at a distance of about 6 cm from the burner) with a constant opening, 8 cm along the axis of the burner and 10 cm in width, covered with an aluminum shutter, *Al*. This length of opening shielded the irradiated material from most of the radiation emanating from the incandescent tungsten anode. In order to vary the intensity (by 1/10, 1/20, 1/35, and 1/50) of the total radiation, I_0, incident upon the material under investigation, this opening was covered lengthwise (that is, along the axis of the burner) with aluminum slits, *Sl*, leaving openings 3 to 8 mm in

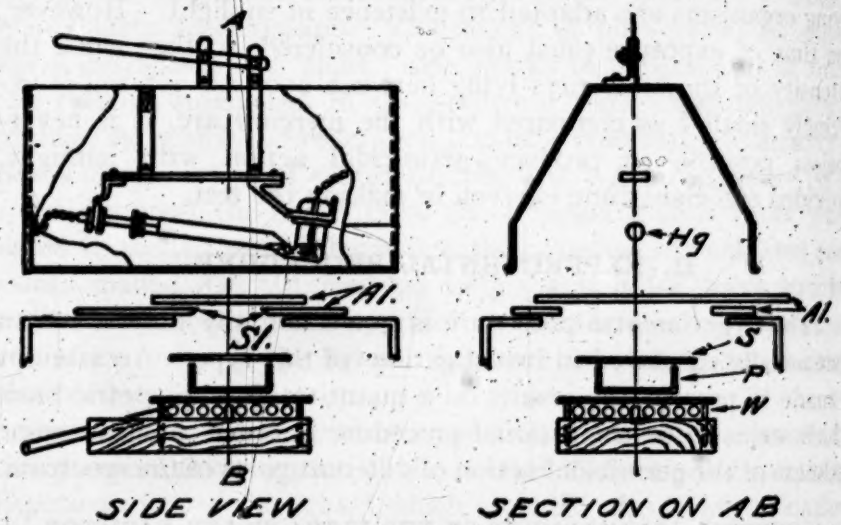


FIG. 1.—*Arrangement of apparatus for studying bactericidal action of ultra-violet light*

length. The width of the opening crosswise to the burner was kept large (10 cm) to avoid errors that might arise from lateral displacement of the burner. A water-cooled stage, *W*, was used to maintain the irradiated material at a uniform temperature. This stage consisted of a copper plate 10 by 10 by 0.15 cm mounted in contact with a coil of thin-walled (0.1 mm) copper tubing through which water was circulated. The material under investigation (say, inoculated agar in a Petri dish, *P*) was placed upon this copper plate. As a further protection from the heat of the lamp an aluminum cover, *S*, with a suitable opening, was placed over the Petri dish.

For compactness and clearness, in this illustration (fig. 1) the relative sizes and distances of the various parts of the apparatus are not drawn to scale.

1389

2. SPECTRAL ENERGY DISTRIBUTION OF THE MERCURY ARC

Data on the distribution of intensities in the spectral lines of the quartz mercury arc burner were published in previous papers.[15] In a special investigation of the physical characteristics of the radiation from quartz mercury arc lamps it was shown [16] that the type of contruction (whether only one or both electrodes are of mercury) has no appreciable effect upon the ultra-violet component radiation. It was found that the ultra-violet component decreases but slowly with usage. Furthermore, since the completion of those early investigations marked improvements have been

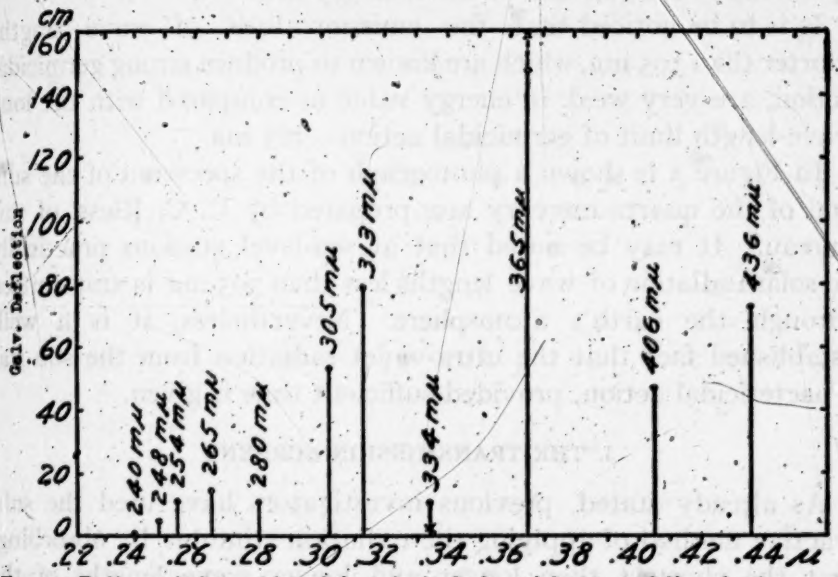


FIG. 2.—*Radiometric intensities of the principal ultra-violet spectral lines in the quartz mercury arc*

made in the construction of this type of burner, which blackens but little with usage.

The burner used in the present investigation was new and was maintained primarily for this work. Hence, the question of deterioration need not be considered.

During the course of this investigation a measurement was made of the ultra-violet component radiation of this burner, using the standard transmission screen of Corning Noviol glass, shade *B*, adopted in previous work.[17] The ultra-violet component radiation of wave lengths less than 405 mμ was 60 per cent of the total radiation of all wave lengths, less than 1,400 mμ, emanating

[15] B. S. Sci. Papers, Nos. 330 and 378.
[16] Amer. Jour. Electrotherapeutics and Radiology, 39, p. 395; 1921.
[17] B. S. Sci. Papers, 15, p. 1; 1918 (No. 330).

from the burner, including the incandescent tungsten anode. This is in exact agreement with previous tests of new burners of this type.

The radiation intensities of the principal emission lines in the ultra-violet spectrum of this quartz mercury arc burner, on normal operation of 320 watts (80 volts, 4 amperes) are illustrated in Figure 2. The relative intensities seem to be somewhat different from that of a 220-volt lamp described in a previous paper,[18] which gives data also on the variation of intensity with power input, and a comparison of the ultra-violet emission spectrum of the sun and of the mercury arc.

It is to be noticed that the emission lines of wave lengths shorter than 305 mμ, which are known to produce strong germicidal action, are very weak in energy value as compared with the long wave-length limit of germicidal action—365 mμ.

In Figure 3 is shown a photograph of the spectrum of the sun, and of the quartz mercury arc, prepared by C. C. Kiess, of this bureau. It may be noted that at sea-level stations practically no solar radiation of wave lengths less than 305 mμ is transmitted through the earth's atmosphere. Nevertheless, it is a well-established fact that the ultra-violet radiation from the sun has a bactericidal action, provided sufficient time is given.

3. THE TRANSMISSION SCREENS

As already stated, previous investigators have used the subtractive method of applying the radiation stimulus by absorbing, first the shortest then longer and longer wave lengths of the lethal rays by means of screens. The present method may be called subtractive and additive. It is based upon the observation, which appears to be novel, that mica has an absorption band with a maximum in the region of 260 mμ. A small variation in thickness produces a relatively large variation in transmission in this spectral region as compared with the transmission at 365 mμ. This is illustrated in Figure 4, curves *3a* and *3b*, which represent the spectral transmissions of a screen of mica, one part of which is thinner than the other. For the spectral region of 240 to 290 mμ (having a high germicidal action, but low energy value for the quartz mercury arc) the thinner part of the screen transmits from 30 to 50 per cent more radiation than the thicker part of the screen, whereas for the spectral lines at 313, 334, and 365 mμ the

[18] Coblentz, Amer. Jour. Electrotherapeutics and Radiology, 39, p. 395, 1921; also B. S. Sci. Papers, No. 330.

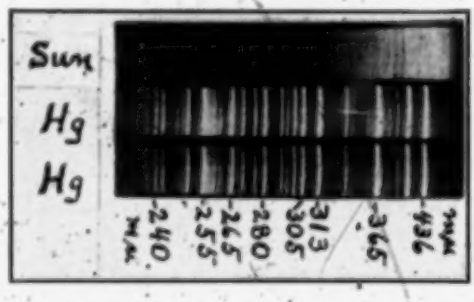


FIG. 3.—*Spectrograms of the quartz mercury arc and of the sun*

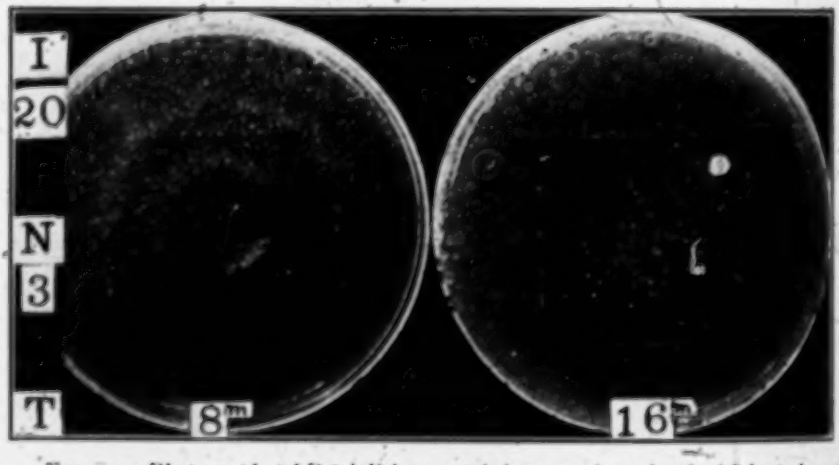


FIG. 5.—*Photographs of Petri dishes containing agar inoculated with bacteria*

The central rectangular area is the part which was exposed to the ultra-violet radiation. The clear area shows the killing action of the rays transmitted through the thinnest part of the mica screen N_3. Intensity, I=20. Exposure, T=8 and 16 min.

transmission is increased only by 5 to 2 per cent, respectively. This difference in transmission greatly accelerates the germicidal action through the thinner film, which would hardly be expected if it were merely a question of total energy increase. For, it so happens that a 2 to 5 per cent increase in energy value of the radiation of wave lengths 313 to 436 mμ gives practically the same integrated value as a 30 to 50 per cent increase in the spectral radiation of wave lengths 240 to 305 mμ (see Table 1, 0.47 against 0.34 cm deflection). Moreover, as mentioned in the discussion of the "Spectral range of abiotic action" using the screen of glass, curve 4, in Figure 4, which transmits only the spectral lines at 313

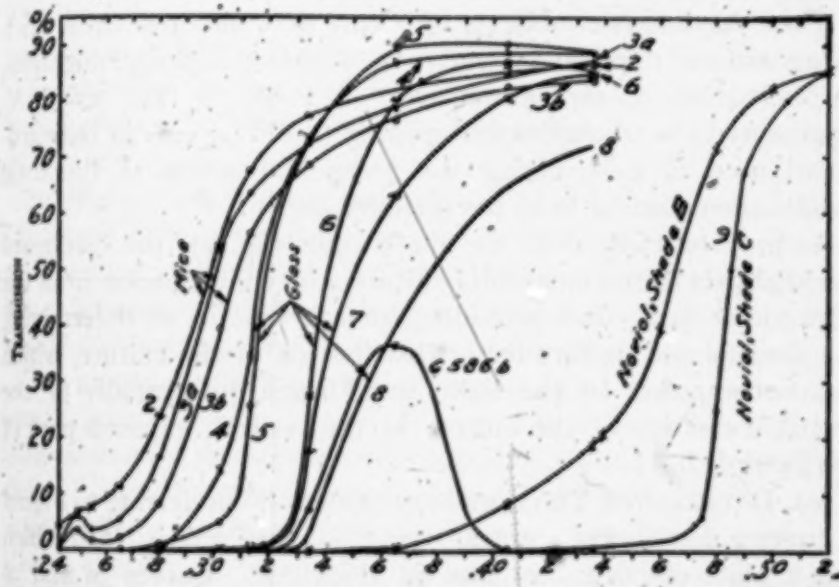


FIG. 4.—*Spectral transmission curves of the screens used in testing bactericidal action*

to 365 mμ, and increasing the intensity by changing the distance, do not accelerate the germicidal action in a manner comparable with that obtained by using the mica screens. (See a further discussion under the section on "The energy required to kill a bacterium.")

The present procedure may, therefore, be considered subtractive, in that all radiations of wave lengths less than about 230 mμ are absorbed, and additive for the spectral region of 240 to 305 mμ, without greatly affecting the region of 313 to 436 mμ, by using mica screens of different thicknesses.

The manner of selecting screens of suitable thickness was by projecting the ultra-violet spectrum upon a fluorescent surface,

prepared as described elsewhere,[19] and noting where fluorescence ceased when the mica screen was interposed before the spectrometer slit.

The uniformity of the thickness of the mica screen was observable by means of the interference colors produced by the light from the mercury lamp. The difference in germicidal action as the result of a difference in thickness of the screen is also observable in the incubated bacterium cultures after exposure to the mercury lamp (see fig. 5). This is well illustrated in the right-hand (16-minute) exposure where the almost complete killing action coincides closely with the irregular cleavage line in the mica.

These screens (size about 4 by 5 cm) were mounted upon thick cardboard and numbered N_2, N_3, etc., as shown in the photographs, or No. 2, No. 3, etc., as recorded in Table 1. The screen N_1 represented the unobstructed opening (4 by 4.5 cm) in the cardboard used in determining the germicidal action of the total radiation emanating from the mercury arc.

As may be noticed in the illustration (fig. 5), the cardboard shielded part of the bacterium culture (the white specks) from the ultra-violet rays, thus providing an easy means of determining the density and uniformity of distribution of the culture, which was not exposed to the light, and, hence, inferentially of the probable density of the culture in the central, exposed part of the Petri dish.

(*a*) DATA ON THE TRANSMISSION SCREENS.—Referring to Figure 4, curve *2* depicts the spectral transmission of screen No. 2 which was a plate of mica, 0.01 mm in thickness. Curves *3a* and *3b* give the transmission of screen No. 3, which was a plate of mica having a maximum thickness of about 0.02 mm. The two areas *3a* and *3b* of this plate of mica differed but little in thickness, nevertheless there is a marked difference in the bactericidal action. These two screens were split from thick mica plates which differed considerably in color, hence in ultra-violet absorption, as affected by the coloring matter in the crystal.

Curves *4* and *5* give the spectral transmission of screens Nos. 4 and 5 of thin, white crown glass, having a thickness of 0.915 and 1.25 mm, respectively.

Curves *6* and *7* depict the spectral transmission of plate window glass, having a thickness of 1.93 and 3.02 mm, respec-

[19] Methods and apparatus in spectroradiometry, Coblentz, Jour. Opt. Soc. Amer., 7, p. 451; 1923.

tively. Viewed edgewise these two samples had a marked greenish tint.

Screen No. 8 was made of two superimposed pieces of window glass, cut from the same plate as screen No. 7, the total thickness being 6.04 mm. These three screens were used in an attempt to establish the long wave-length limit of bactericidal action. The transmission of the 313 mμ line through these screens, Nos. 6, 7, and 8, was 0.4, 0.2, and 0.04 per cent, respectively.

Photographs were made of the quartz mercury arc spectrum, through these screens by Dr. W. F. Meggers, of the spectroscopy section of this bureau. Spectrograms of exposures, some of which were sufficiently prolonged to fog the plate, showed the 313 mμ line through screen No. 6 (Tr. = 0.4 per cent), but showed no impression of this line through screen No. 7 (Tr. = 0.2 per cent).

In Figure 4, curve 9 illustrates the spectral transmission of a yellow, shade *C*, Corning Noviol glass screen, having a thickness of 1.97 mm.

In Figure 4 is given the transmission of a Corning glass, G586J (thickness 2.78 mm), which has a high transmission for the 365 mμ line and an immeasurably small transmission for the 313 mμ line. Spectrograms of 10 minutes exposure showed only a faint impression of the 313 mμ line upon the photographic plate.

The quartz mercury arc emits practically no radiation of wave lengths lying between 436 and 546 mμ. Hence, the shade *C* Noviol glass establishes the long wave-length limit at 436 mμ. As will be shown presently, the abiotic action of the radiation of wave lengths 365 to 436 mμ is very slow in spite of their high intensity. Hence, there is no need of including radiation of longer wave lengths in this investigation.

4. CALIBRATION OF THE RADIATION INTENSITY

One important reason for undertaking the present investigation was to attempt to place the germicidal action of ultra-violet radiation on a quantitative radiometric basis. While there can be no longer any doubt that the greatest abiotic action is produced by ultra-violet radiation of very short wave lengths, as noted in the introductory part of this paper there is need of information concerning the energy relations involved in germicidal action in different parts of the ultra-violet spectrum.

Photographs of the emission spectrum of the quartz mercury arc burner (see fig. 3) show that the ultra-violet spectrum consists

of a number of sharp emission lines superposed upon a weak, continuous background.[20]

The distribution of intensities in these (radiometrically measurable) spectral lines extending from 220 to 436 mμ, when the burner was operated on 320 watts (80 volts, 4 amperes) is given in Figure 2. The relative intensities of the spectral lines vary with the power input, as shown in a previous paper.[21] In the present research the potential applied to the burner was held constant from day to day at 79 to 80 volts, or close to 320 watts.

In the quartz-mercury arc the intensity of the continuous spectrum is weak in comparison with the intense emission lines, which are widely separated and, hence, easily measured radiometrically. Hence one can easily calculate the intensity of the radiation stimulus for a given spectral region and compare it with the observed value, as obtained through the various transmission screens. This is accomplished in the following manner: First, an estimate is obtained of the total energy in the whole spectral region by taking the sum of the galvanometer deflections of all the measurable emission lines (see fig. 2) extending from 220 mμ to, and including, 436 mμ. Similarly the amount transmitted through the various screens is obtained by multiplying the intensities of these emission lines by the spectral transmissions, given in Figure 4, and taking the sum of the transmitted intensities. The ratio of these two summations gives the per cent transmission of the radiation of wave lengths less than (and including) 436 mμ, which, for the present investigation, is taken to be the long wave-length limit of germicidal action. Experimentally this long wave-length limit was obtained by using a shade *C* Noviol glass screen (see fig. 4), which is opaque to wave lengths less than 405 mμ, and transmitted only 0.3 per cent of the mercury line at 436 mμ.

The amount transmitted through the various screens was determined experimentally in the following manner: A thermopile, covered with a 1 cm cell of water, was used as a radiometer, as in previous measurements of this type.[22] It was placed at a fixed distance (16 cm) from the burner and the galvanometer deflection (26 cm; see Table 1) was noted; also the galvanometer

[20] Souder, Phys. Rev. (2), 8, p. 316; 1916. In this paper as well as in one by Kopplus, Phys. Rev. (2), 18, p. 450; 1922, energy measurements are given of the intensities of the spectral lines. The relative intensities of these lines depend, of course, upon the power-input, and, hence, the data are not necessarily comparable with the measurements given in the present paper.

[21] Coblentz, Amer. Jr. Electrotherapeutics and Radiology, 39, p. 405; 1921.

[22] B. S. Sci. Paper, No. 330.

deflection (9 cm) when the shade *C* Noviol glass was interposed. The difference in the galvanometer deflections (17 cm) is a measure of the ultra-violet radiation, extending from 170 to 436 mμ. Using the glass screen No. 6 (see fig. 4) the galvanometer deflection was 17.8 cm. The deflection for wave lengths 320 to 436 mμ is, therefore, 8.8 cm. Similarly, a deflection of 12.5 cm was obtained for the ultra-violet transmission through glass screen No. 2. The ratio of the deflections for these two screens, No. 6÷No. 2, gives the transmission (71 per cent) of the radiation of wave lengths between 220 and 436 mμ. The calculated value is 72 per cent. Similar data, for other spectral regions are given in Table 1, showing the close agreement between the observed and the calculated values of the radiation transmitted through (or excluded by) these various screens. The fact that there is such a close agreement between the calculated values using the dispersed radiation, and the observed values, using the undispersed radiation, seems to indicate that the energy value of the radiation of wave lengths less than 220 mμ (which was neglected in the calculations, because it was absorbed by the spectroscope, though present in the undispersed radiation) is extremely small. Nevertheless, the radiation of wave lengths less than 220 mμ has a powerful bactericidal action.

To recapitulate, the foregoing demonstration of the close agreement between the calculated and the observed transmissions serves two purposes, viz, (1) it shows the small energy value of the radiation of wave lengths less than 220 mμ, emitted by the quartz-mercury arc, which radiation is quite immeasurable because of absorption in a quartz spectroradiometer, and (2) it shows the reliability of the transmission data which were obtained only by calculation.

An estimate of the radiation intensity in absolute value was obtained by calibrating the galvanometer deflection, by exposing the thermopile to a standard of radiation.[23] In this manner it was determined that a galvanometer deflection of 1 cm $= 5 \times 10^{-6}$ watt per square millimeter and that the radiant flux of wave lengths 170 to 1,400 mμ was $I_o = 0.00013$ watt per square millimeter at a distance of 16 cm from the burner. This represents the full intensity, I_o, used in these experiments. Intensities of 1/10, 1/20, 1/35, and 1/50 were also used, as already described.

[23] B. S. Bull., 11, p. 87; 1914.

This value is in exact agreement with previous measurements[31] in which it was found that the radiant flux of wave lengths less than 1,400 mμ at 16 cm from a 220-volt burner was 0.00044 watt per square millimeter. This was 3.4 times the average intensity of several 110-volt burners, or 0.00013 watt per square millimeter for the 110-volt burner. It is to be understood, of course, that only a small proportion of this energy is of wave lengths which have any abiotic action. This question will be discussed in a subsequent section in which an estimate will be obtained of the energy required for killing cultures of bacteria.

TABLE 1.—Data on the Energy Transmitted and Absorbed (Including the Part Reflected; 9 per cent) by the Various Screens Used in Bactericidal Tests. A Deflection of 1 cm = 5×10^{-6} watt per mm² at a distance of 16 cm from the burner

Screen	Spectral limits of transmitted radiation	Radiation transmitted		Screen	Spectral limits of absorbed radiation	Radiation absorbed = transmitted	
		Galvanometer deflection	Galvanometer correction for reflection			Galvanometer deflection	Per cent of total to 436 mμ
	mμ	cm			mμ	cm	
No. 1, no screen	170 to 1,400	26.0	26.0	No. 1—No. 9	170 to 436	*16.2	100.0
No. 2, mica	220 to 1,400	21.5	23.4	No. 1—No. 2	170 to 220	*2.6	16.1
No. 3, mica	240 to 1,400	20.6	22.4	No. 1—No. 4	170 to 280	*4.4	27.1
No. 4, glass	280 to 1,400	19.8	21.6	No. 1—No. 5	170 to 280	*4.8	29.6
No. 5, glass	280 to 1,400	19.4	21.2	No. 2—No. 4	220 to 280	*1.7	10.5
No. 6, glass	320 to 1,400	17.8	19.4	No. 3a	240 to 305	1.2	10.3
No. 9, Noviol glass	436 to 1,400	9.0	9.8	No. 3b	313 to 436	10.4	89.8
				No. 3a—No. 3b	240 to 305	0.34	28.3
				No. 3a—No. 3b	313 to 436	.47	4.5
				No. 2—No. 5	220 to 305	2.2	.....

Screen	Spectral limits of transmitted radiation	Galvanometer deflection	Per cent of total	Screen	Transmission	
					Observed	Calculated
	mμ	cm				
No. 1—No. 9	170 to 436	17.0	100.0	No. 3+No. 2	0.92	0.92
No. 2—No. 9	220 to 436	12.5	74.2	No. 5+No. 3	.90	.92
No. 3—No. 9	240 to 436	11.6	68.3	No. 6+No. 5	.85	.85
No. 4—No. 9	280 to 436	10.8	63.6	No. 6+No. 2	.71	.72
No. 5—No. 9	280 to 436	10.4	61.2	No. 6+No. 3	.77	.78
No. 6—No. 9	320 to 436	8.8	51.8	.....	.....	.....

* Corrected for reflection.

5. SPECTRAL TRANSMISSION OF SOME CULTURE MEDIA AND AMINO ACIDS

In the introductory part of this paper experimental data were cited showing that organisms having cell walls which are highly opaque to ultra-violet radiation are very resistant to the lethal action of these rays.

[31] H. S. Sci. Paper No. 330, Tables 6 and 7.

The absorptivity of the culture medium must also be considered. In our tests, using the Petri dishes, the bacterial cultures were sown on the surface of the nutriment agar, and, hence, the depth of penetration of the rays into the culture medium is of secondary importance.

However, for certain determinations it would be desirable to use suspensions of bacteria in liquid media, in which case the depth of penetration of the abiotic rays into the medium is an important factor in the killing action. Our preliminary experiments on the germicidal action of ultra-violet radiation on suspensions of *B. coli* in distilled water showed appreciable experimental error, owing to considerable dying of the bacteria in the stock suspension before a large series of exposures could be completed.

An examination was, therefore, made of the spectral transmission of certain nutrient solutions to determine their transparency, and, hence, their suitability in studying the abiotic action of ultra-violet radiation.

The investigations of Kreusler [25] and of others show that the spectral transmission of pure (freshly distilled) water is high throughout the range from 200 to 300 mμ. After standing for a short time in a soft-glass container, enough glass is dissolved to reduce the spectral transmission; for example, using a cell 1.7 cm in thickness, Kreusler observed that at 200 mμ the absorption of fresh water was 31.8 per cent, and, after standing in a glass bottle for half a day, the absorption increased to 70.6 per cent. By storing the water in hard-glass containers there was little change in the absorption.

(*a*) WATER.—In connection with the present investigation, the spectral transmission was determined immediately after making the bactericidal tests of distilled water suspensions of *B. coli*, and of similar suspensions in water containing a small proportion of nutrient material; for example, 1/40 and 1/500 dilutions of standard beef-peptone bouillon and also a 1 per cent solution of peptone. In Figure 6 is illustrated, by means of the circles (○○○) the spectral transmission (uncorrected for reflection and absorption of the quartz windows) of a 1 cm layer of water, containing about 600,000 *B. coli* per cubic centimeter.

From this it may be noted that the water suspension of *B. coli* absorbs but little of the abiotic rays.

[25] Kreusler, Ann. der Physik (4), 6, p. 412; 1901.

(*b*) BOUILLON.—In Figure 6 the circles (○○○) depict the spectral transmission of a 1 cm cell containing beef-peptone bouillon, the concentration being 1/40 of the standard strength (3 g beef extract, 10 g peptone, and 5 g sodium chloride per 1,000 cm³ distilled water).

In this same illustration the crosses (x x x) depict the spectral transmission of a 1/500 solution of bouillon. In the weaker concentration the absorption band at 250 mμ is almost eliminated, thus permitting the abiotic rays to penetrate a water suspension

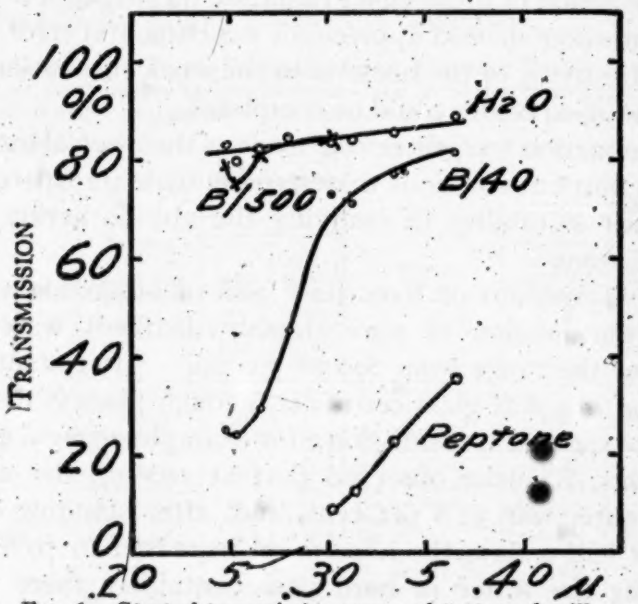


FIG. 6.—*Spectral transmission curves of peptone, bouillon, and water*

of bacteria with practically undiminished intensity relative to the more dense solution.

(*c*) PEPTONE.—In Figure 6 is illustrated the spectral transmission through a 1 cm thickness of water containing 0.01 g/cm³ of peptone, and about 600,000 *B. coli* per cubic centimeter. This nutrient material developed a deep-brown color during sterilization and has a high absorption of the abiotic rays, which, as will be shown in a subsequent part of this paper, greatly retards the killing action.

From this it appears that, because of their great opacity to ultra-violet radiation, standard strength solutions of beef bouillon and of peptone are optically unsuitable as liquid nutrient media in germicidal tests.

(*d*) TYROSIN AND PHENYLALANIN.—These amino acids are supposed to be some of the absorbing substances forming the cell walls of bacteria and protozoa. According to Kober [26] a water solution of tyrosin has an absorption band extending from 248 to 297 mμ, and phenylalanin has a similar band extending from 236 to 271 mμ. Hence, some investigators have assumed that ultra-violet radiation of this spectral region should be most toxic to protoplasm. No quantitative spectral transmission measurements were made in the present investigation. However (in connection with the use of these materials as transmission screens, to be discussed presently), by projecting the ultra-violet spectrum upon a fluorescent screen [27] it was found that dilute solutions of these substances have a narrow absorption band comprised within the limits established by Kober, the maximum absorption being in the region of 270 to 280 mμ.

6. BIOLOGICAL MATERIAL AND METHODS

Bacterium coli communis, recently isolated from human feces, was used as a test organism, largely because this species has been included in practically all experiments dealing with the bactericidal effect of ultra-violet light, and despite the fact that *B. coli* has given evidence of showing a certain amount of irregularity in its reaction to the radiation, which may have been due to clumping or to individual differences in resistivity. The cultures used were on standard beef-peptone agar and were grown for three days at room temperature of about 22° C. A loop of the abundant surface growth was transferred to sterile distilled water, using the proper dilution to give the desired thickness in the final sowing of the organism. The suspension was atomized as uniformly as possible over the surface of a Petri dish containing hardened sterile beef-peptone agar made up to be rather firm (2 per cent agar shreds). It was found advantageous to direct the nozzle of the atomizer upward and to hold the Petri dish in an inverted position some 30 cm away so as to avoid large droplets. With care in judging the amount of surface growth transferred on the loop, and the amount of suspension atomized over the surface of the plate, fairly uniform sowings were secured. As soon as practicable after preparation the exposures to the ultra-violet light were made. In a large series with long exposures one or two hours sometimes necessarily intervened in the case of particular plates,

[26] Kober, Jour. Biol. Chem., V, 22, p. 433; 1915.
[27] Coblentz, Jour. Opt. Soc. Amer. and Rev. Sci. Insts., 7, p. 451; 1923.

but check plates did not show any serious error from this delay. However, when making exposures using long wave lengths (365 mμ) after the inoculated plates had stood for four hours, a noticeable retardation in the killing action was observed. Exposed plates were held three or four days at room temperature before records were made. The counts were made under a reading glass magnifying four diameters.

This method has the advantage of exposing the organisms in a thin layer very uniformly to the action of the ultra-violet rays and of permitting the rapid handling of a large series of exposures. It is particularly useful for determining the time for practically complete killing. It is not an accurate method for determining the rate of numerical decrease during the earlier stages of killing, for the reason that each droplet of liquid in thick seeding contains more than one organism, and no decrease in number of colonies is evidenced until the killing has become complete for many of the droplets. If the droplets could be made to carry uniformly one organism each, this method would then be satisfactory for determining the rate of killing from the beginning of the lethal effect.

The method of plating out from water suspensions of the organism exposed for different periods is the ideal one for determining the rate of bactericidal action. Our results from the use of this method, as has been heretofore mentioned, have seemed to be influenced by several complicating factors, among them the difficulty of maintaining a constant number of organisms in the stock suspension during the progress of an extended test, and it must be improved in details before the maximum accuracy in results is obtained.

The method used by some previous investigators of securing complete sterilization of a suspension of bacteria in a nutrient solution is open to the threefold objection, (1) that the medium itself may act as a highly protective screen, (2) that considerable irregularity may result from the chance survival of a few organisms for abnormally long periods, and (3) that the progressive rate of killing can not be determined.

III. EXPERIMENTAL DATA

1. EFFECT OF ULTRA-VIOLET LIGHT UPON THE CULTURE MEDIUM

In the introductory part of this paper the experiments of Browning and Russ were cited, showing that the ultra-violet light had no effect upon the uninoculated (agar) culture medium.

1401

They found no difference in the density of growth of the organisms over the portions of the agar which were irradiated and non-irradiated before inoculation.

Similar results were obtained in the present investigation for the intensities and times requisite for complete killing. However, when using very high radiation intensities it was found that the ultra-violet light had sufficient effect upon the uninoculated beef-peptone agar, so that, after inoculation, there was considerable mortality of the *B. coli*.

The experimental procedure was to hold the Petri dish of uninoculated beef-peptone agar for various times from 4 to 64 seconds at a distance of about 5 cm from the mercury arc burner. The intensity was, therefore, about 10 times that used in our regular experiments. The dishes were then atomized at once ($T=0$ hours) with a culture of *B. coli* and incubated for four days. The results are shown in Figure 7, in which No. 1 and the left-hand side of No. 2 are photographs of parts of the unexposed control dishes. The density of the inoculation (the white flecks) shows the thickness of the sowing of *B. coli*.

The right-hand side of dish No. 2 and the whole of dish No. 3 were exposed to ultra-violet radiation before inoculation. This caused a high mortality or inhibition of growth of the *B. coli*. The white flecks are a measure of the number of bacteria which survived. No. 2 is especially conspicuous in showing the effect of the ultra-violet radiation upon the culture medium.

It is relevant to add that this was first noticed on some Petri dishes of uninoculated agar which had become contaminated with mold spores. As a quick means of killing these spores, the dishes were exposed to intense ultra-violet radiation before inoculation. It was then found that while this is a ready and effective means of disinfecting the culture medium, it had a disastrous effect upon the subsequent cultures. Aside from establishing this fact no attempt was made to determine the exact cause of this failure to grow or how long after exposure this deleterious action continued in the culture medium.

In conclusion it is important to emphasize that our results, in general, are in agreement with those of recent investigators, showing that the killing of bacteria by ultra-violet rays is not due to the small amounts of toxic chemical substances that may be produced by the action of the rays on the water or other medium.

Our control tests show that this holds true for the standard beef-peptone agar used in the work, for the periods and intensities of exposure necessary to secure complete killing effect, and that changes in the culture media are a negligible factor in the killing effects observed. However, when the Petri dishes containing the beef-peptone agar were given excessive exposures to the ultra-violet, either by greatly prolonging the time of preexposures or by bringing the dishes very close to the lamp and thus increasing the intensity and possibly the spectral range of the radiation, it was found, as just described, that subsequent seeding on the surface of the preexposed agar gave no growth or only a small number of colonies as compared with portions of the same dish that had been shielded from exposure to the radiation. That a drying or cooking effect of the agar surface caused by heat radiation was not responsible for the observed result was shown by the fact that agar exposed to similar intensities of heat radiated from a flatiron supported a normal growth of *B. coli* when later inoculated. A single test of potato agar and of carrot agar, showed no deleterious effect from preexposure to ultra-violet light of the intensities that did so affect beef-peptone agar.

2. DEATH OF BACTERIA IN DISTILLED WATER

In most of our work a freshly prepared suspension of bacteria in distilled water (about 500,000/cm^3) was used for distributing the organism over the surface of the agar. It was observed that the number of bacteria decreased appreciably in the distilled water suspension if it was held several hours at room temperature.

The regular procedure was to atomize the freshly prepared suspension upon all plates of any series, at the beginning of the test. There was no evidence of any important increase or decrease in numbers of colonies on the plates during the time necessarily consumed in making a large series of exposures to ultra-violet radiation. Even if there was some numerical change, due to dying or to natural multiplication, the experimental findings would not be affected, because only part of each Petri dish was exposed to ultra-violet radiation, and the effect of this irradiation was judged by comparison with the adjacent unexposed portion of the same plate.

In Figure 7 the densely flecked photograph No. 1 shows (part of) a control Petri dish inoculated with a freshly prepared (time in hours $T=O$) suspension of *B. coli* in sterile distilled water. Photograph No. 4 shows a similar control dish which was inoculated with this same suspension of *B. coli* after it had been stand-

ing three hours ($T = 3$) at room temperature. Both of these plates were inoculated under the same conditions.

The lower No. 4 is almost free from the white flecks, which is a measure of the comparative number of colonies of *B. coli*, which had survived after being in the distilled water for three hours.

In Figure 7 the photographs Nos. 5 and 6 show the combined effect of exposure of the agar before inoculation and the effect of using a distilled water suspension of *B. coli* after standing for three hours. These two plates are entirely free from white flecks, showing complete absence of bacterial growth (1) due to some inhibiting or lethal action in the preexposed culture medium, and (2) to the high mortality of the bacteria in the water suspension before inoculation of the culture medium.

These photographs are excellent illustrations of the precautions that are required in making a test in order to be certain that the results obtained are attributable to the causes which are supposed to produce them.

3. EFFECT OF CONTINUOUS AND INTERMITTENT EXPOSURE

Considerable experimental data were obtained in order to determine whether there is any difference in the germicidal action of ultra-violet radiation when the total exposure is applied (1) continuously and (2) intermittently with short and long intervals of rest.

The experimental procedure was to expose the Petri dish of thickly inoculated beef-peptone agar to the total, unobstructed radiation (that is, no screen intervened) of the quartz mercury burner. The intensity, $I \div 50$, was selected so as to eliminate errors from too rapid germicidal action relative to variation in shutter speed. The total time of exposure of 48 to 80 seconds was selected, because from previous experience this was found to give good plates which could be counted.

The results (see Table 2) of an examination of the plates showed but little, if any, difference in the density of the growth of bacteria, whatever the method of exposure. From this it would appear that the intermittent exposure does not have a latent effect during the intervals of rest, either in stimulating growth or in continuing the lethal action, and that the lethal effect is additive even with rest periods many times longer than the exposure periods.

It is relevant to add that in the practical applications of ultra-violet light to the killing of microorganisms it would usually be the

case that a particular organism would not be exposed continuously to the rays, but would be shielded more or less intermittently by other individuals, or perhaps by foreign objects. As already stated, by making continuous exposures of thickly seeded plates for sufficient times to kill 50 per cent or more of the organisms present, and also by making discontinuous exposures, the summations of which equaled the respective times of continuous exposures (as shown in Table 2), the effects on *B. coli* on the surface of beef-peptone agar were practically the same where the total times of exposure were equal, whether uninterrupted or in parts. This agrees with the conclusion of Bovie [28] as to the additive effect of Schumann rays.

TABLE 2.—Effect of Continuous and Discontinuous Exposure Upon the Bactericidal Action of Ultra-Violet Rays on *B. coli*

Total exposure (seconds)	Method of exposure	Colonies surviving
		Per cm²
64	1 Exposure of 64 seconds, continuous	83
	2 Exposures of 32 seconds each, with 1 rest of 64 seconds	87
	4 Exposures of 16 seconds each, with 3 rests of 64 seconds	85
	8 Exposures of 8 seconds each, with 7 rests of 64 seconds	75
	16 Exposures of 4 seconds each, with 15 rests of 64 seconds	73
48	4 Exposures of 16 seconds each, with 3 rests of 286 seconds	76
	1 Exposure of 48 seconds, continuous	130
	8 Exposures of 6 seconds each, with 7 rests of 6 seconds	117
80	1 Exposure of 80 seconds, continuous	37
	16 Exposures of 5 seconds each, with 15 rests of 5 seconds	39
	Average, check plates, unexposed	257

4. SPECTRAL RANGE OF ABIOTIC ACTION

The spectral range of wave lengths which have a marked abiotic action is most easily demonstrated by means of the aforementioned transmission screens. A measure of the speed of the lethal action is obtained by counting the surviving colonies of bacteria after various intervals of exposure, through the various screens.

As shown in Table 1, the energy transmitted by the screens (for example, No. 2 and No. 4) is not sufficiently different to account for the great difference in killing action, which is attributable in part to radiation of short wave lengths absorbed by the screen. As an extreme example we may take No. 1 – No. 9 (17 cm deflection) and No. 6 – No. 9 (8.8 cm deflection). The intensity of the radiation transmitted through the latter is about one-half that available when no screen intervened. Hence, if it were merely a question of intensity, as will be shown presently, by using

[28] Bovie, Bot. Gaz., 61, p. 1; 1916.

1405

twice the time of exposure through screen No. 6 approximately the same killing action would be obtained as when using no screen. But such is not the case; for an exposure of 15 to 45 minutes through screen No. 6 was required to produce the same killing action upon *B. coli* as was obtained by a one to two second exposure to the unfiltered radiation.

The photographs in Figure 8 are an excellent demonstration of the effect of wave length upon the bactericidal action of ultra-violet radiation. For obtaining the photographs shown in this illustration two intensities, $I \div 50$ and $I \div 35$, were used. When using the intensity $I \div 50$ the Petri dishes were exposed to the unobstructed (N_1) radiation for $T = 1$, 2, and 4 minutes; and when exposed under the mica screen (N_2) the time of exposure was $T = 8$, 16, and 32 minutes. When using the weaker intensity, $I \div 35$, the exposure time was 0.5, 1, and 2 minutes, respectively, for N_1, and 4, 8, and 16 minutes, respectively, for N_2.

It will be understood, of course, that the central rectangular area represents the part of the culture which was exposed to radiation. The surrounding border is part of the Petri dish which was not exposed to radiation, and hence shows the density of the culture.

The number of surviving colonies (the white flecks) in these rectangular areas shows that, when using the mica screen, N_2, it was necessary to expose the culture about eight times as long in order to obtain the same killing as for the unobstructed radiation, N_1. The data given in Table 1 show that the mica screen, N_2, transmitted 74.2 per cent (obstructed about 26 per cent) of the radiation of wave lengths 220 to 436 mμ and about 16 per cent of the wave lengths 170 to 220 mμ. The energy value of these two radiation stimuli (N_1 and N_2) is so closely (within 26 per cent) the same that, if it were merely a question of intensity, it would not have required an eight times longer exposure to produce the same killing with radiation of wave lengths 220 to 436 mμ as when this same radiation included also the wave lengths 170 to 220 mμ.

Further experimental evidence is given in the photographic illustrations in Figures 10 and 11 showing that, in order to obtain the same killing action, at least an eight times longer exposure must be made through the mica screen, N_2, than when using the complete spectrum, N_1.

For making these tests a rather heavy suspension of *B. coli* in distilled water was atomized over the surface of beef-peptone

agar. The unexposed portions of the plate gave an estimate of 200 colonies per square centimeter after three days incubation. Table 3 gives the percentages of colonies developing in the same time on the exposed portion of the plate.

TABLE 3.—Giving the Percentages of Colonies of *B. coli* Which Developed in the Same Time on the Exposed Portion of the Petri Dish

Screen	Time of exposure														
	Seconds						Minutes								
	1	2	4	8	15	30	1	2	4	11	16	22	32	45	64
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Unexposed	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
G586 J	.....	.....	.....	.....	.....	.....	.....	.....	100	77	6.1	2.0	.....	1.6	0
No. 8	.....	.....	.....	.....	.....	.....	.....	.....	100	64	3.9	.5	.....	.4	0
No. 3, thick part	.....	.....	.....	100	90	50	2.5	.5	.....	.....	.....	.....	.....	.....	.....
No. 2	.....	.....	90	60	1	.1	.1	.....	.....	.....	.....	.....	.....	.....	.....
No. 1, full intensity	30	0.5	.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

These data are illustrated in Figure 9. In the lower part of this illustration the curves for screens N_1, N_2, and N_3 are replotted to a larger scale in order to bring out more clearly the relationships of these curves to each other.

The conclusion to be arrived at from the foregoing experiments is that radiation of wave lengths greater than 305 mμ is capable of producing abiotic action. However, the rate at which this can be accomplished, when using only a quartz mercury arc lamp, is only about one-eighth as rapid as obtains with the addition of the shorter wave lengths. The fact that certain experiments cited in the foregoing part of this paper placed the long wave-length limit of bactericidal action at 295 mμ is to be ascribed to the very much lower intensities one can obtain in spectrally dispersed radiation and to the fact that the time of exposure was not sufficiently prolonged. If 295 mμ were the long wave-length limit, then no germicidal action could be obtained with sunlight, which is contrary to common experience, provided sufficient time is given to obtain the results.

(*a*) THE LONG WAVE-LENGTH LIMIT OF ABIOTIC ACTION.—It seemed desirable to determine, if possible, the longest wave lengths which have a germicidal action. The difficulties involved are great, owing to the fact that, with increasing wave length of the exciting radiation, the rate of abiotic action decreases, and, with the long exposures required to obtain marked killing, it is necessary to guard against germicidal action by heating.

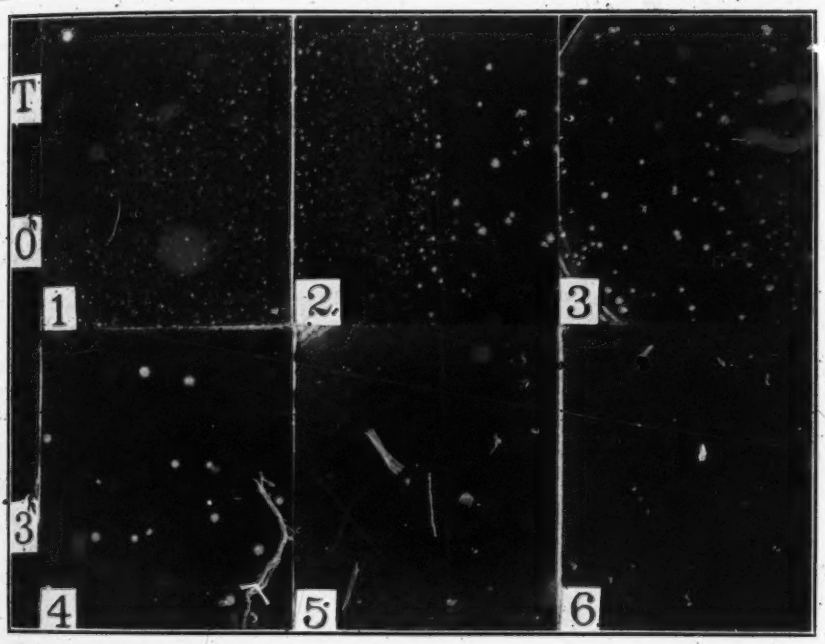


FIG. 7.—*Effect of ultra-violet light upon the uninoculated culture medium (agar); also death of bacteria in distilled water. (Time, T, in hours)*

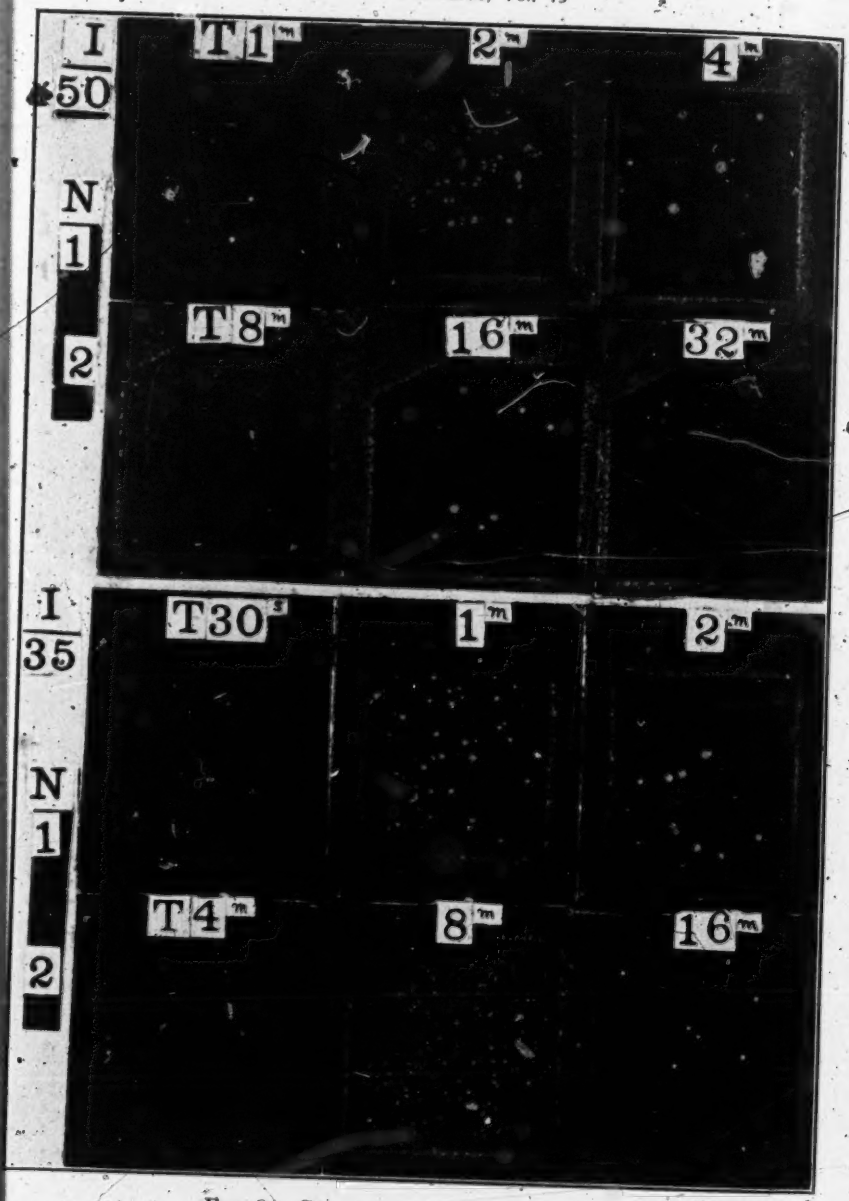


FIG. 8.—*Spectral range of abiotic action*

The tests were, therefore, made by mounting two screens (each 3.5 by 4 cm) side by side, upon heavy cardboard, having an opening 4 by 7 cm. In addition to the shields depicted in Figure 1,

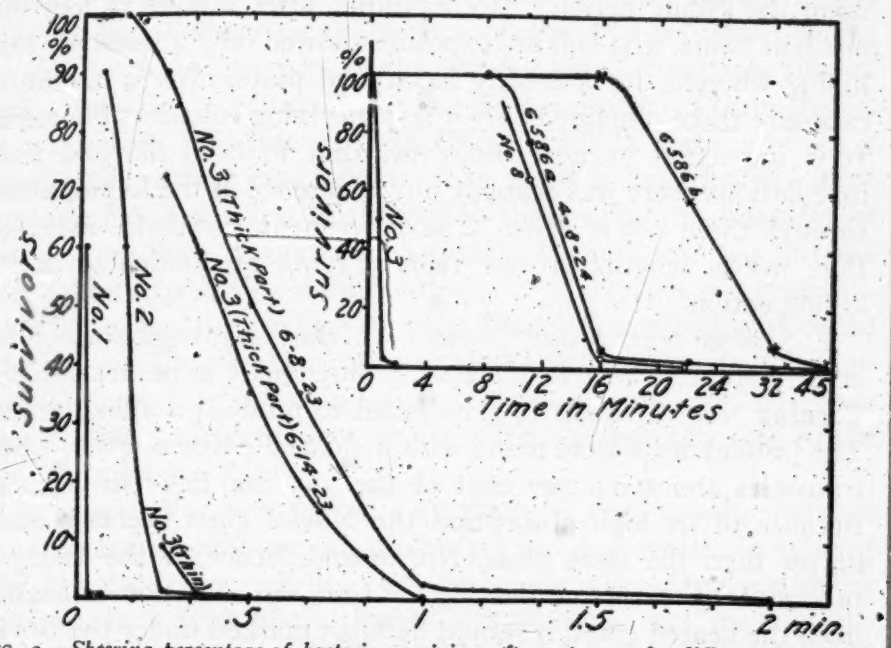


FIG. 9.—*Showing percentage of bacteria surviving after exposure for different lengths of time, under various screens*

an aluminum reflector was placed directly over these glasses; and, in one series of tests, a thick wooden block intervened between the aluminum shield and the glass plates.

By exposing the inoculated material in the Petri dish simultaneously to the full intensity, *I*, through the two screens, experimental conditions were the same within the inclosure.

The spectral transmissions of these screens are given in Table 4.

TABLE 4.—Per Cent Transmission Through Glass Screens

Screen	Wave lengths in mμ		
	313	334	365
No. 6	0.4	27.5	80
No. 7	.2	18.0	63
No. 8	.04	3.0	40
Noviol B	0	0	0.7
G586J	0	7.5	36.6

1. *Screens Nos. 6 and 7.*—Five series of exposures of 1 to 90 minutes duration gave consistent results, showing the same percentage of killing through these two screens. In the freshly

inoculated dishes the killing action through No. 6 was a little more rapid than through No. 7. The time elapsing between inoculation and exposure of the plates had a noticeable effect upon the killing action. For example, after a lapse of four and one-half hours, a 22-minute exposure showed only a small per cent killing whereas, for a freshly inoculated plate, after a 22-minute exposure there remained only a few surviving colonies of bacteria. It is important to note, however, that in both old and fresh inoculations there was scarcely any difference in the killing action through these two screens. The experimental evidence indicated that wave lengths greater than 313 mμ predominated in the killing action.

2. *Screens Nos. 8 and Noviol.*—In the very beginning of this investigation it was found that a three-hour exposure through Corning Noviol, shade *C*, glass failed to produce a killing action. The present tests were made with a shade *B*, Noviol glass, which transmits about 0.6 per cent of the 365 mμ line (see fig. 4). Because of its high absorption the Noviol glass becomes much hotter than the clear glass, No. 8, and, hence, if the killing is produced by excessive heating, by infra-red radiation emanating from the heated glass, it should be most marked under the Noviol glass screen.

Using freshly inoculated Petri dishes, complete killing through screen No. 8 was obtained in 45 to 64 minutes, whereas an exposure of two hours showed no killing effect upon the bacteria exposed under the Noviol *B* screen. From this it may be concluded that the heat radiated from the glass screens did not affect the bacteria, and that radiation of wave lengths greater than 365 mμ has only a very slow, if any, germicidal action.

3. *Screens Nos. 7 and 8.*—The Noviol glass and the clear glass screen No. 8 restrict the abiotic action practically to the 334 and the 365 mμ lines.

Using a freshly inoculated dish, complete killing through No. 7 was obtained in 45 minutes while a trace of surviving colonies (0.4 per cent) remained under No. 8. Using dishes which had stood four to five hours after inoculation, an exposure of 90 minutes was required to obtain practically complete killing through screen No. 7 (0.3 per cent survivors), while under screen No. 8 there remained 12.5 per cent survivors. The point of interest, however, is that in both cases the killing action through these screens is so closely the same, in spite of the fact that the 313 mμ

line, which might have caused the killing, was practically excluded by screen No. 8.

No doubt both the 334 and the 365 mμ line have an abiotic action. However, when using screen No. 7, the intensity of the 365 mμ line is about 52 times that of the 334 mμ line. Using screen No. 8 the intensity of the 365 mμ line is 200 times that of the 334 mμ line. Although the 365 mμ line obtained through No. 8 is relatively less intense than through No. 7 (ratio 40÷63) a good killing action is obtained. The slight retardation in killing through No. 8 may be attributed to the decrease in intensity of the 365 mμ line. From this analysis it appears that the 365 mμ line has an appreciable abiotic action. This conclusion is strengthened by the results obtained with the Noviol glass, which eliminated the 365 mμ line and thus prevented abiotic action. In this connection it may be noted injurious effects upon the eye have been noted when wearing glasses which did not completely absorb the 365 mμ mercury line.

4. *Screens Nos. 8 and G586.*—In the foregoing tests the screens transmitted a small amount of the 313 mμ line, which, in spite of the low intensity, might, perhaps, cause the observed killing action. In a final effort to establish that the 334 mμ and the 365 mμ lines have a relatively strong abiotic action a series of exposures was made of cultures of bacteria to ultra-violet light, through the highly selective transmission screen G586 (see fig. 4), which is exceedingly opaque to the 313 mμ line. Two samples differing slightly in thickness were used.

Since the intensity of the 313 mμ line is immeasurable and the intensity of the 334 mμ line, as transmitted through this screen, is only 1/80 that of the 365 mμ line, it would seem that the latter would contribute the most in the lethal action. As already mentioned, the intensity of the 365 mμ line through screen No. 8 is 200 times that of the 334 mμ line and 2,000 times that of the 313 mμ line.

A series of exposures of 11, 16, 22, 32, 45, and 64 minutes duration was made through these two screens (No. 8 and G586) mounted side by side, as already described.

Each Petri dish was inoculated with a freshly prepared suspension of *B. coli* just before exposure, thus eliminating aging, and fairly consistent results were obtained from day to day.

The lethal action obtained through screen No. 8 was found to be more rapid than through screen G586, as would be expected

since it transmitted about 8 per cent more of the 365 mμ line than the latter. The most important result, however, is that after excluding a possible lethal action of the 113 mμ line, even more thoroughly by means of the screen G586 than by screen No. 8, that complete killing was obtained in an hour, as previously observed with screen No. 7. From this it is a reasonable conclusion that, since the intensity of the 365 mμ is 80 times that of the 334 mμ line, it exerts a relatively powerful lethal action, provided sufficient time is given in making the test. The relative intensities of these two lines are indicated by crosses (x x) in Figure 2.

In the insert of Figure 9 is illustrated the counts of the per cent of surviving bacteria after various times of exposure through these two screens. For the short exposures the per cent of survivors is subject to variation from day to day, owing partly to a small difference in the transmission through these two samples of glass, and also to a probable difference in the suspensions of bacteria. However, all the data are consistent in showing a strong lethal action which effected complete killing in 45 to 64 minutes.

(*b*) SHIELDING ACTION OF THE CULTURE MEDIUM.—In a preceding section of this paper the question of suitable culture media was considered, and spectral transmission curves were given of several media, including peptone (fig. 6), which has a high absorption for the most active germicidal rays. This absorption has a marked retarding effect upon the killing action.

In these tests the suspension of bacteria in the liquid medium (for example, water containing 0.01 g/cm³ of peptone) was exposed in open quartz dishes (25 by 30 by 30 mm) to the ultra-violet rays. The depth of the liquid was about 10 mm.

By plating dilution samples that had been exposed for two minutes to an intensity of $I \div 50$, it was found that the numbers surviving out of every 1,000 organisms originally in the several media were as follows: Water, 5; for 1/500 bouillon, 34; for 1/40 bouillon, 52; for 1 per cent peptone, 832. After an exposure of one minute, the survivors per 1,000 for 1/500 bouillon were 68, and for 1/40 bouillon, 220; and with exposure of one-half minute the survivors were 146 and 740, respectively. This indicates a much weaker penetration of the ultra-violet rays into the more concentrated bouillon.

From this it is evident that peptone (or any medium having great opacity to ultra-violet radiation) is optically unsuitable as a nutrient in liquid suspensions of organisms which are to be subjected to germicidal tests. For the medium has the properties of the above-described absorption screens.

(*c*) ABIOTIC ACTION THROUGH SCREENS OF SOLUTIONS OF AMINO ACIDS.—Harris and Hoyt [29] in an attempt to determine what substances in bacteria are affected by the action of ultra-violet light, found that solutions of tyrosine and of amino-benzoic acid used as screens detoxicated the ultra-violet light passing through so that bacteria, when dried on cover slips and exposed under these screens, survived exposures up to 16 to 35 times those required to completely kill by the use of unscreened ultra-violet. Since the substances used absorb ultra-violet light of wave lengths 236 to 297 mμ, these investigators conclude that practically all of the rays toxic for protoplasm should lie within this range. However, from the foregoing tests, using screens of mica and of glass, it is evident that, given sufficient time and intensity, good killing action can be obtained with wave lengths longer than 297 mμ. Furthermore, the tests with the Schumann rays show that the extremely short wave lengths are also very toxic.

We have tested two of the materials, tyrosine and phenylalanine, discussed by Harris and Hoyt, using beef-peptone agar plates atomized over the surface with a heavy suspension of *B. coli* instead of the less sensitive method with bacteria dried on cover slips. The exposures were made at a distance of 16 cm (I_0) from the quartz-mercury arc lamp, through a circular cell 25 mm in diameter, and 1 cm in thickness with quartz sides. The phenylalanine was used in 1 per cent aqueous solution, and the tyrosine in a saturated aqueous solution at room temperature of 22° C., which was approximately 0.04 per cent. Distilled water was used as a check. It was found that 10 per cent of the bacteria survived exposure of one second through the water screen; that 56 per cent survived eight seconds, and none survived 30 seconds' exposure through the 1 per cent phenylalanine solution; and that 53 per cent survived 30 seconds, and none survived 120 seconds through the saturated tyrosine solution.

It is thus seen that, under the conditions of our test, *B. coli* is by no means perfectly protected from killing when wave lengths

[29] The action of ultra-violet light on certain bacteria in relation to specific absorption by amino acids, by F. I. Harris and H. S. Hoyt, in University of California Publications in Pathology, 2, No. 21, pp. 245–250; 1910.

236 to 297 mμ are screened out provided sufficiently long exposures are made. It is, therefore, incorrect to conclude that bactericidal effect is restricted to wave lengths absorbed by such substances as tyrosine and phenylalanine. It must be observed in passing that the intensity and range of absorption by solutions of these substances vary according to the concentration of the solution and the thickness of the layer through which the light passes. In the living bacterial cell the conditions in these respects would be very different from those obtaining in the experiments reported.

5. EFFECT OF INTENSITY UPON ABIOTIC ACTION

In various practical problems, such as, for example, the sterilization of water, it is of importance to determine the effect of the intensity of the radiation stimulus upon the time of exposure required to produce a fixed, though not necessarily complete, mortality in a culture of bacteria.

In the present experiments the intensities used were $I \div 1$, $I \div 10$, and $I \div 50$. In one series of experiments, using the unfiltered radiation, N_1, the corresponding times of exposure were 2, 20, and 100 seconds, respectively. As shown in the upper horizontal row of illustrations, in Figure 10, a two-second exposure to $I \div 1$ effected complete killing of the *B. coli*, whereas the 100-second exposure to $I \div 50$ was not sufficiently prolonged to kill all the bacteria. In other words, there is no exact relation between the intensity and the time of exposure.

This is illustrated to better advantage by selecting Petri dishes which have suffered the same bactericidal action, as shown in the lower horizontal row of photographs in Figure 10, and noting the time required to produce the same effect.

When using the filtered radiation, obtained by means of the mica screen, N_2, the bactericidal action is not so rapid and is, therefore, less subject to errors in timing the exposures. In Figure 11 the upper horizontal row of photographs shows the central (exposed) parts of the inoculated Petri dishes, having approximately the same number of surviving colonies of *B. coli;* the time of exposure being 10 seconds for $I \div 1$ and 600 seconds for $I \div 50$.

In this same illustration the central and the lower horizontal rows of photographs show the number of surviving colonies after an exposure of 15 seconds for $I \div 1$. From these two rows of photographs it may be noted that, in order to produce the same mortality when using an intensity of $I \div 50$, as was obtained with

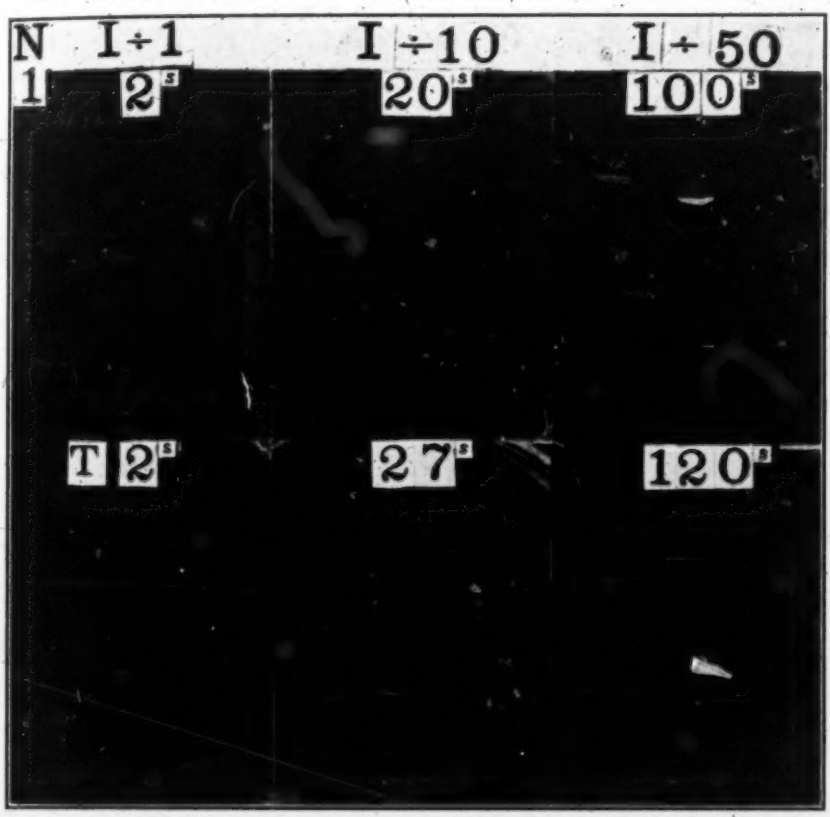


FIG. 10.—*Effect of intensity upon the time of exposure required to obtain the same killing action, using unfiltered ultra-violet radiation*

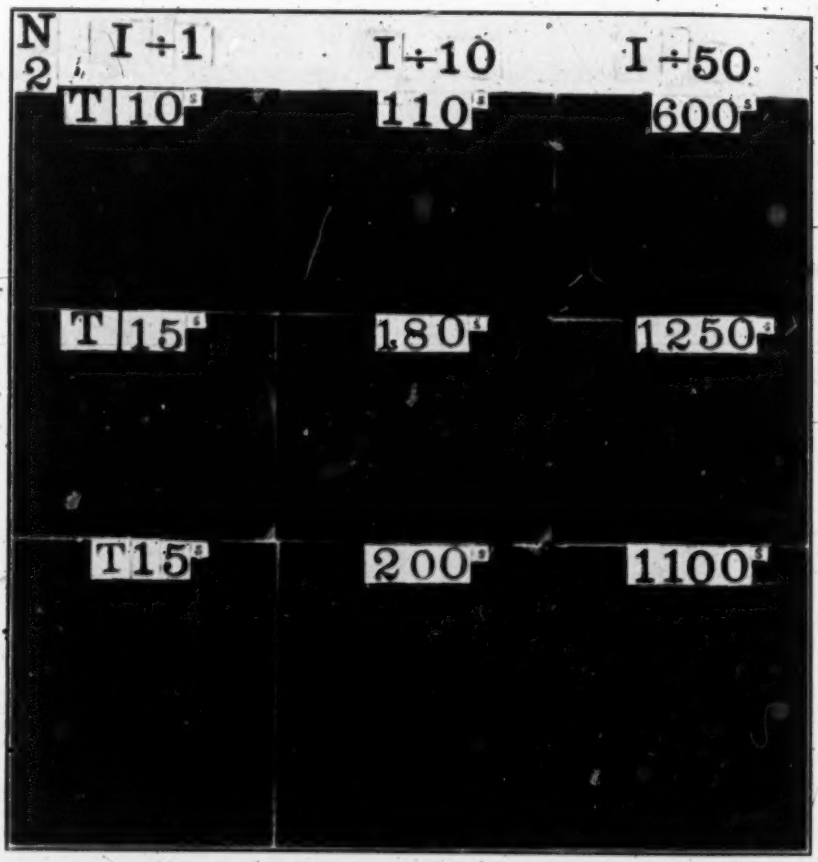


FIG. 11.—*Effect of intensity upon the time of exposure required to obtain the same killing action upon bacteria, using filtered ultra-violet radiation*

$I \div 1$, the time of exposure lies between 1,100 and 1,250 seconds, or an intensity-time factor lying between 73 and 83. In Figure 11, the plates for 200 and 1,250 seconds were damaged by blotches of moisture, but this does not interfere with the interpretation of the clear areas. The results obtained when the time of exposure was increased by the same ratio that the intensity of radiation was decreased are given in Table 5. It will be noted that with lowering of the intensity a proportionate increase in the time of exposure falls short of bringing about an equal killing effect. Screens with less transmission than N_2 were not used because of the exceedingly long exposures that would have been required with the low intensity of radiation.

TABLE 5.—Survivors of *B. coli* (Percentages) at Different Intensities and Exposure Time Factors

Intensity × time factor	Survivors	
	No. 1 (no screen)	No. 2
	Per cent	Per cent
$\frac{1}{1} \times 1$ s.	0.06	.....
$\frac{1}{10} \times 10$ s.	1.8	.....
$\frac{1}{50} \times 50$ s.	2.8	.....
$\frac{1}{1} \times 10$ s.	.....	18.
$\frac{1}{10} \times 100$ s.	.....	44.
$\frac{1}{50} \times 500$ s.	.....	67.
$\frac{1}{1} \times 15$ s.	.....	.17
$\frac{1}{10} \times 150$ s.	.....	17.
$\frac{1}{50} \times 750$ s.	.....	23.

It may be noted that the percentage of survivors rises with exposures of lessened intensity in spite of the time of exposure having been proportionately increased.

In this test, as well as in a subsequent one, exposures were made at various short periods before and after the times selected for obtaining the data given in Table 5. From observation of the results, those times of exposure were selected that gave approximately the same killing effect (see figs. 10 and 11), and their ratios were calculated. The results are given in Table 6.

TABLE 6.—Giving the Ratios of the Time of Exposure Required to Produce the Same Killing of *B. coli*, Using Different Intensities

Screen	Intensity		
	I/1	I/10	I/50
No. 1	1	14	60
	1	18	90
	1	10	55
Average, three tests	1	14	68.3
No. 2	1	13	90
	1	13	73
	1	12	67
	1	12	75
Average, four tests	1	12.5	76.2

Since killing was very rapid at full intensity with the unscreened light, N_1, there was a chance for some inaccuracy in the data due to the difficulty of correctly timing the short exposures. On the whole, the data show a definite increase in the time ratios, over the reciprocal intensity ratios $I \div 10$, for an equal killing effect. Using the intensity $I \div 50$ there is a very marked increase in the time ratios.

From the foregoing data it appears that, for the intensities used in this investigation, when using low intensities ($I \div 50$) it is necessary to increase the time of exposure about 75 times in order to effect the same killing as was obtained on full intensity. The practical application to water sterilization and similar problems seems evident.

6. THE ENERGY REQUIRED TO KILL A BACTERIUM

It will be useful to obtain an estimate of the energy involved in germicidal action. For this purpose it is sufficient to consider radiation of wave lengths less than 313 mμ, which has a rapid abiotic action. By utilizing the above-mentioned additive and subtractive principle we shall confine our attention to the spectral region which includes the emission lines at 240 to 305 mμ.

The experimental tests were made by mounting two or three pieces of mica or glass side by side upon a perforated cardboard support, which was then placed over the Petri dish.

The mica screen, No. 3, already mentioned, which consists of two well-defined areas of different thickness is well adapted for performing the experiment in this manner. The bactericidal action under the two areas progresses simultaneously, using two different intensities of radiation, while all other factors, such as,

1415

for example, temperature, humidity, etc., within the Petri dish remain constant.

Probably the most conspicuous example of increasing the speed of bactericidal action observed in the present investigation is by the use of the above-mentioned mica screen No. 3. As shown in Table 1, the (calculated) difference in transmission of the radiation of wave lengths 313 to 436 mμ amounts to only 4.5 per cent (0.47 cm) or about 2.3×10^{-6} watt per square millimeter. Since the bactericidal action of the radiation in this spectral range is known to be very weak we may consider that this part of the radiation stimulus (relative to the total, which amounts to 52×10^{-6} watts per square millimeter) remained constant.

On the other hand, in the spectral region extending from 240 to 305 mμ, the intensity of the radiation stimulus transmitted by these two thicknesses of mica differs by 28.3 per cent (0.34 cm) or about 1.7×10^{-6} watt per square millimeter out of a total of 6×10^{-6} watt per square millimeter. As shown in the lower part of the photograph (fig. 5) of the Petri dish which was exposed for 16 seconds, this 28 per cent additional radiation greatly accelerated the lethal action, causing practically complete killing in 16 seconds, whereas under the thicker part of the mica screen perhaps 50 per cent of the culture survived.

In order to obtain an estimate of the energy required to kill a bacterium it is necessary to consider the size of the object exposed. Published data[30] show that the average length of *B. coli* is 1.0 to 2.0 μ, and the width about 0.5 μ. The area of a bacterium exposed to radiation is, therefore, about 8×10^{-7} square millimeters.

(*a*) Abiotic Action, No Screen.—Referring to Table 1 (No. 1 to No. 5) the energy value of the most active germicidal radiation (from the mercury arc) of wave lengths 170 to 280 mμ, for I_o, was observed to be 4.8 cm or 24×10^{-6} watt per square millimeter. It was repeatedly observed that an exposure of one second to the unobstructed radiation, I_o, effected complete killing of a culture of *B. coli*. Assuming that all the radiation of wave lengths 170 to 280 mμ, is intercepted, conserved, and utilized in lethal action, then the total energy required to kill a bacterium amounts to $(24 \times 10^{-6} \times 8 \times 10^{-7} =) 19 \times 10^{-12}$ watt or 4.5×10^{-12} g cal.

(*b*) Abiotic Action, Mica Screen No. 2.—Using mica screen No. 2 the spectral range of the most active germicidal rays is confined to the wave lengths 220 to 280 mμ. The energy value

[30] Bergey's Manual of Determinative Bacteriology, Society of American Bacteriologists: 1923.

is (2.2 cm or) 11×10^{-6} watt per square millimeter, or 88×10^{-11} watt per bacterium.

An exposure of about 15 seconds was required to effect complete killing of the *B. coli* under this screen. The total energy used, is therefore, 132×10^{-12} watt or 31.4×10^{-12} g cal. This is seven times greater than was required when the radiation stimulus included rays of wave lengths 170 to 220 mμ. As already shown, when using an intensity of $I \div 10$, the time of exposure required to effect complete killing is somewhat greater (13 instead of 10 seconds) than the inverse of the intensity. In the present instance the intensities differ by 2.2. On this basis, if it were merely a question of intensity, then an exposure of about seven seconds would have been sufficient to effect complete killing. It is, therefore, to be concluded that the greater lethal action of the unobstructed radiation is to be attributed to the presence of the short wave-length radiation, extending from 170 to 220 mμ, which, according to these calculations, have from six to seven times the killing power of the radiation at 220 to 280 mμ. This, of course, is in agreement with the qualitative data of other investigators cited in the first part of this paper.

To recapitulate, the foregoing experiments and calculations show two important facts: (1) That the total energy of wave lengths 170 to 305 mμ, required for germicidal action is very small and (2) that, in order to produce a rapid killing action with a quartz-mercury arc lamp, the lethal radiant flux must exceed a threshold value, which for the present may be considered to be of the order of 25 microwatts per square millimeter.

IV. SUMMARY

Although the literature is replete with reports of investigations of the germicidal action of ultra-violet radiation but little information is at hand regarding the energy relations involved.

In the present investigation an attempt is made to present the results on a radiometric basis, which seems to be the logical procedure in order to obtain some estimate of the germicidal action of different parts of the spectrum.

The subtractive and additive method of attacking the problem was used. The subtractive principle consists in eliminating different portions of the ultra-violet spectrum by means of absorption screens. The additive principle, the use of which appears to be novel, is based upon the discovery of a well-defined absorption

band at about 260 mμ, in mica. A small variation in thickness of the mica screen produces a large variation in transmission in this spectral region relative to the rest of the spectrum in which the transmission remains practically constant.

The source of ultra-violet radiation was a quartz-mercury arc lamp. The test organism was *Bacterium coli communis* suspended in sterile distilled water. This suspension was atomized uniformly over the surface of a Petri dish, containing hardened sterile beef-peptone agar, and then exposed to ultra-violet radiation.

In the preliminary tests it was found that exposure of the standard uninoculated beef-peptone agar to ultra-violet radiation, of the intensities and for the time of exposure used in this investigation, had no effect upon the subsequently seeded surface. However, when using a very high radiation intensity, a subsequent seeding of the surface of the preexposed agar gave no growth, or only a small number of colonies of bacteria.

An investigation was made (1) of the spectral range of bactericidal action, (2) of the effect of varying the intensity of the exciting light, and (3) of the method of exposure, whether continuous or intermittent.

From various experimental data it appears that germicidal action is produced by ultra-violet radiation throughout the spectral range extending from the very short wave lengths (Schumann rays) to and including 365 mμ. The shortest rays have the most violent lethal action, which decreases in intensity with increase in wave length.

The long wave-length limit of abiotic action is not well defined. Previous investigations have been interpreted as indicating that the long wave-length limit of abiotic action is in the region of about 297 mμ. In the present investigation, when the time of exposure was sufficiently prolonged, killing of bacteria was obtained through screens which transmitted ultra-violet radiation of wave lengths longer than 297 mμ, including the 365 mμ line. But no abiotic action was obtained through screens which transmitted only wave lengths longer than 365 mμ for the exposures used. The present tests, therefore, show that the long wave-length limit of ultra-voilet abiotic action includes the wave length, 365 mμ, and explains the bactericidal action obtained in sunlight.

The lethal action of radiation of wave lengths longer than 305 mμ was found very slow in comparison with radiation of wave

lengths less than 280 mμ, even though the latter was much lower intensity. Using the ultra-violet radiation emanating from the quartz-mercury arc the lethal action of the wave lengths less than 280 mμ is estimated to be at least 10 times more rapid than that of the wave lengths greater than 305 mμ.

Tests were made to determine the abiotic action of ultra-violet radiation when the total exposure is applied (1) continuously and (2) intermittently with short or long intervals of rest. No difference in the density of the growth of bacteria could be observed whatever the method of exposure. From this it appears that the intermittent exposure does not have a latent effect, either in stimulating growth or in continuing the lethal action, during the intervals of rest, and that the killing effect is cumulative.

On low intensities the killing action is greatly retarded; for example, using an intensity of $I + 50$ it was necessary to expose the inoculated plate for 75 to 80 seconds instead of 50 seconds in order to secure the same killing effect as when using unit intensity and unit time. On still lower intensities there are some (although not thoroughly verified) indications of stimulation instead of lethal action.

It is shown that the energy value of the most active germicidal radiation from the quartz-mercury arc of wave lengths 170 to 280 mμ required to kill a bacterium is very small, being of the order of 19×10^{-12} watt or 4.5×10^{-12} g cal.

A further deduction is that, in order to produce a rapid abiotic action (in one second) the radiant flux of the germicidal radiation from the quartz-mercury arc must exceed a certain threshold value, which is of the order of 25 microwatts per square millimeter. This is obtained at a distance of about 15 cm (6 inches) from a 110-volt mercury in quartz arc lamp consuming about 320 watts (80 volts, 4 amperes) in the burner.

WASHINGTON, May 31, 1924.

[fol. 853] PLAINTIFFS' EXHIBIT No. 75

Florida Citrus Exchange Bulletin

Tampa, Florida, December 6, 1926.

To all Directors of the Florida Citrus Exchange.

GENTLEMEN: Please be reminded that the next regular meeting of the Board of Directors of the Florida Citrus Exchange, will be held in the offices of the Exchange at Tampa, Florida, on Wednesday, December 15, 1926, at the hour of 1:00 P. M.

The Executive Committee will meet at 10:00 A. M. on the same date.

For your information, we enclose a copy of the minutes of the two meetings of the Executive Committee, held since the last regular meeting of the Board.

Yours very truly, Florida Citrus Exchange. O. M. Felix, Secretary.

OMF-ER.

Minutes of Meeting of Executive Committee of the Florida Citrus Exchange, Held at Tampa, Florida, on Wednesday, October 27, 1926, at the Hour of 2:00 P. M.

Present: E. L. Wirt, Chairman; John A. Snively, F. C. W. Kramer, Jr., John S. Taylor, H. E. Cornell, W. W. Yothers, B. F. Stewart.

[fol. 854] Absent: W. O. Talbot.

Also present: C. C. Commander, Geo. A. Scott, A. H. Blanding, John Moscrip, O. M. Felix, P. C. Peters, Earl Hunter, L. A. Hakes, H. E. Blair, J. Reed Curry.

Upon motion made, seconded and duly carried, the minutes of the last meeting of the Executive Committee were approved as read by the Secretary.

A committee from the Orange County Citrus Sub-Exchange appeared and presented their claim relative to the cancellation of a $5,000.00 note held by the Florida Citrus Exchange against that Sub-Exchange. After presentation of the case it was moved, seconded and duly carried, that the matter be referred to the Board of Directors at their

next meeting, with a recommendation from the Committee that it be reconsidered.

The proposition of the Exchange using the auction market at Baltimore during the approaching season, was presented by a delegation from Orange County and upon motion made, seconded and duly carried, it was moved that the matter be referred to Mr. Geo. A. Scott of the Sales Department for adjustment.

A letter from Mr. B. E. Morrill, relative to demoralized condition in Dade County Sub-Exchange, on account of [fol. 855] results of the storm, was read before the Committee. After discussing the matter it was moved, seconded and duly carried that the General Manager be authorized to continue the operations of this Sub-Exchange, direct from the Tampa office, as other small sub-exchanges are operated.

The General Manager submitted his report covering his investigation of the W. E. Lee matter which upon motion made, seconded and duly carried, was approved and accepted.

The General Manager submitted his recommendations relative to continuing the activities of the Exchange Sales Company, as follows:

Executive Committee, Florida Citrus Exchange, Tampa, Florida.

GENTLEMEN: As per your instructions at the meeting September 15th, beg to make the following recommendations:

That we continue the activities of the Exchange Sales Company under its present name.

That we adopt a uniform system of reporting by all offices handling an account of the Exchange Sales Company. I have given some thought to the proper form to be used in reporting to this office and recommend their adoption and to instruct the Cashier to send these to the various offices with instructions for their uses.

I further recommend that F. W. Davis be the nominal head of the Exchange Sales Company for soliciting accounts and that he investigate and recommend to this office for our approval, every account that we accept in the future.

[fol. 856] That we make a strenuous effort to increase our tonnage. Under the proper management there is no reason why we would not be able to earn a large part of our expenses in the various offices.

Respectfully submitted.

C. C. Commander, General Manager.

Upon motion made, seconded and duly carried the recommendations were approved and accepted.

Upon motion made, seconded and duly carried, it was moved that the Committee recommend to the Board of Directors the election of Mr. M. G. Campbell, as a Special Director.

Upon motion made, seconded and duly carried, it was moved that recommendations of Mr. Geo. E. Koplin, relative to bulge pack and standardized boxes, be referred to the Board of Directors for consideration at their next meeting.

The Auditors Annual Statement of Exchange operations for the past season was presented and upon motion made, seconded and duly carried, it was moved that a copy be sent to each director and that the report be considered at the next meeting of the Executive Committee.

Upon motion made, seconded and duly carried, Mr. B. F. Stewart was excused from the meeting, on account of his train being due to leave in a very short time.

The matter of the Exchange participating in the Florida Exposition Train was presented and upon motion made, seconded and duly carried, it was moved that the Chairman appoint a committee to make an investigation with [fol. 857] authority to expend $6,000.00 for half-unit if they deem it advisable, Chairman Wirt to act as Chairman of the Committee. The Chairman then appointed the following as members: F. C. W. Kramer, Jr., John S. Taylor, C. C. Commander.

Reports were submitted by the heads of the various departments, outlining the work done and progress made for the season to date.

There being no further business to come before the Committee, upon motion made, seconded and duly carried it was moved to adjourn until the third Wednesday in November, 1926.

E. L. Wirt, Chairman.

Minutes of Meeting of Executive Committee of the Florida Citrus Exchange, Held at Tampa, Florida, on Wednesday, November 17, 1926, at the Hour of 2:00 P. M.

Present: E. L. Wirt, Chairman; John A. Snively, H. E. Cornell, John S. Taylor, B. F. Stewart, W. O. Talbott, W. W. Yothers.

Absent: F. C. W. Kramer, Jr.

[fol. 858] Also present: C. C. Commander, Geo. A. Scott, A. H. Blanding, O. M. Felix.

Upon motion made, seconded and duly carried, the minutes of the last meeting of the Executive Committee, were approved as read by the Secretary, after the addition of the General Manager's report regarding the activities of the Exchange Sales Company.

Mr. Wirt, Chairman of the Committee on the Florida Exposition Trains, reported that after due consideration of expense, probable sales value etc., the Committee recommends that the Exchange decline to participate in the proposition.

Upon motion made, seconded and duly carried, it was moved that the report of the Committee be approved and accepted.

A Distribution Report of sales to November 14, 1926, was submitted by the Sales Manager as follows:

Distribution Report

To November 16, of this season, we have sold 704 cars of fruit, distributed as follows:

Auction Sales	125
Private Sales	579

The 579 cars sold at private sale were distributed as follows:

Territory	Cars	Markets	Customers
West & N. W.	28	20	25
Middle West	189	35	72
Eastern States: Texas & Okla.	250	48	78
Southeast	112	31	38
Total	579	134	213

[fol. 859] Of the 579 cars sold 230 are enroute, or not reported as accepted, leaving 349 accepted to date. The dis-

tribution of the 349 cars, with comparisons to even date last season are indicated below:

Item	1926-27	1925-26
Towns Sold	98	77
New Markets	0	0
Customers Sold	155	128
New Customers	12	6

Grapefruit Shipments November 8 to 16

Date	State	Exchange
November 8	247	48
" 9	81	34
" 10	149	33
" 11	130	33
" 12	95	17
" 13	127	30
" 15	165	38
" 16	55	10
Total	1049	243

Present quotations on grapefruit are $2.50 to $2.75 f. o. b. shipping point. On oranges of desirable sizes and good quality, quotations range from $4.00 to $4.50 per box f. o. b. shipping point, with discounts on 250's and smaller. Many competitors are quoting freely on oranges at $3.50 to $3.75.

Upon motion made, seconded and duly carried, the report of the Sales Manager was approved and accepted.

[fol. 860] The following report of operations to date was submitted by the Manager of the Production Department:

November 17, 1926.

Mr. C. C. Commander, Gen. Mgr., Tampa, Florida.

DEAR SIR: Since the date of my last report October 27, the Exchange has moved 231 cars of oranges and 433 cars grapefruit. Our inspection force has had a very difficult task to handle the grade in such a way as to keep it at the desired level and still protect the grower, as there is a large amount of fruit which while of Sealdsweet texture and general quality, has considerable storm markings. This, we believe has been successfully done and complaints

from the markets as to grade and pack have been very few. The serious difficulty encountered with small sized oranges at the opening of the season has disappeared and sizes in general are running well.

The Department has kept constantly in touch with the State Inspection service and while it has not been possible to secure a 100% stoppage of green fruit shipments, the operations of the fruit bootleggers has been materially curtailed.

The efforts of Mr. Rust, Sub-Exchange Manager in Polk County have been of great value in this line.

Probably the most valuable accomplishment of the Department during this period has been its success in getting the State Inspection service to reverse its decision that Temple Oranges would have to have a maturity certificate, which requirement, if insisted upon, would have resulted in [fol. 861] a large percentage of this fruit drying out before it could be moved, as it is, we believe that we shall be able to secure more satisfactory results with Temples than heretofore by moving them at an early date.

The use of Zeltrocide treatment as now perfected has been recommended to our Associations and is now in process of installation in a considerable number of them. It is believed that in all houses not equipped with precooling plants, a considerable saving will be effected by the use of this treatment.

Cooperation of Association Managers in regulating shipments has been good and argues well for a successful handling of this important requirement for the season.

Yours very truly, A. H. Blanding, Production Manager.

Upon motion made, seconded and duly carried, the report of the Production Manager was approved and accepted.

A request from the Fruit Products company of Florida, regarding the use of the Sealdheart label on canned grapefruit was presented by the General Manager. Upon motion made, seconded and duly carried it was moved that their request for the privilege of using the Sealdheart Trade Mark and Label be granted, but that no reference be made to Sealdsweet or the Florida Citrus Exchange on any labels used, after the present supply is exhausted, without permission from the Florida Citrus Exchange.

The General Manager presented a proposition from the Fruit Products Company of Florida in which they propose to lease the Exchange packing house at Eagle Lake, now [fol. 862] occupied by them as a canning plant. Upon motion made, seconded and duly carried, it was moved that the matter be referred to the President and General Manager, with power to act.

The Lease Agreement with the Zeltrocide Chemical Corporation was presented as follows:

License and Lease Contract

This license and lease contract, made and entered into in duplicate at the City of Tampa, County of Hillsborough, and the State of Florida, this 18th day of November, A. D. 1926, by and between Zeltrocide Chemical Corporation, a corporation organized and existing under the laws of the State of Florida, hereinafter referred to as "the Licensor," and Florida Citrus Exchange a corporation organized and existing under the laws of the State of Florida, with its general offices in the City of Tampa, Hillsborough County, Florida, hereinafter referred to as "the Licensee."

Witnesseth, That whereas, the licensee is the marketing agency of, and through which, under contracts with them, sundry citrus growers associations in the State of Florida market their citrus fruits, and handles the output of the packing houses of such associations.

Whereas, the Licensor is the sole and exclusive owner of all rights and claims covered by certain applications for United States Letters Patent, which are now pending in the patent office of the City of Washington, United States of America, and has made Application for and is about to apply for patents in Great Britain, Spain, Australia, Africa and Palestine, for a formula solution mixture or combination of chemicals designated and known as [fol. 863] Zeltrocide which is used for the cleansing and preservation of fresh fruit and vegetables in their original state, a list of which patent application is annexed hereto, made a part hereof and marked "Schedule A."

Now, therefore, this license and lease contract witnesseth, That in consideration of the sum of one ($1.00) Dollar in United States coin or its equivalent, in hand paid to the Licensor by the Licensee, the receipt whereof by the

Licensor is hereby acknowledged, and also in consideration of other good and valuable considerations and of the mutual covenants of the parties as hereinafter set-forth, the parties hereto covenant and agree as follows:

(a) A license for the whole and entire State of Florida, to use Zeltrocide and any and all other formulas, solutions, mixtures or combinations of chemicals, apparatus and processes covered by the claims of the patent applications and/or patents now or hereafter during the life of this License, owned or controlled (directly or indirectly) by the Licensor, and which are or may be used or useful in the cleansing or preservation of fresh fruit and vegetables in their original state, such license to apply to any or all citrus fruit packing houses, desiring the service, that are now or may be during the life of this license owned, leased and/or operated and/or controlled by the Licensee, the output of which is marketed by or through the Licensee, located in the several Counties in the State of Florida.

(b) The right, for a period of three (3) years from the date, hereof to grant sub-licenses to any and all Associations, operated and/or controlled by the Licensee for the use of Zeltrocide and all other formulas, solutions, mixtures or combination of chemicals, apparatus and processes [fol. 864] covered by the claims of the patent applications and/or patents during the life of this License owned or controlled (directly or indirectly) by the Licensor, and which are or may be used or useful in the cleansing and preservation of fresh fruit and vegetables in their original state.

The terms "Packing Houses," "Licensee's Packing House" and "Packing Houses of the Licensee," as hereinafter used in this License, shall be deemed to mean any or all citrus fruit Packing Houses in the State of Florida, that desire the service, the output of which is marketed by or through the Licensee. The term "Zeltrocide" used in this License, shall be deemed to mean and include any and all formulas, solutions, mixtures or combinations of chemicals and/or apparatus and/or processes, which under the terms of this License, the Licensee or its sub-licenses are authorized to use.

(2) The Licensor covenants and agrees to sell, deliver and install a complete unit of machinery for the application of Zeltrocide, to the Licensee and its Associations, at and for the price of Twenty-Five Hundred Fifty ($2,550.00) Dollars, payable as follows: ——, the Association having the same installed shall furnish at its own cost and expense, all switches and wiring.

(3) The Licensor further covenants and agrees to sell and deliver to the Licensee and its Associations, Zeltrocide and/or other combinations of chemicals used by the Licensor in the cleansing and preservation of fresh fruit and vegetables in their original state; at cost of such chemicals, plus cost of manufacturing and delivering charges and expense, but in no event shall such costs and charges for such chemicals, exceed Sixteen Dollars and Fifty [fol. 865] ($16.50) cwt.; said merchandise to be paid for monthly at the end of each current month.

(4) The Licensor further covenants and agrees, to at all times carry all parts necessary for the repair of the machinery mentioned in the foregoing paragraph, and to sell and deliver the same to the Licensee at cost, plus twenty per cent (20%) for carrying charges, said parts to be paid for when delivered.

(5) The Licensor agrees to furnish Licensee a sufficient and satisfactory bond, in the sum of Twenty Thousand ($20,000.00) Dollars guaranteeing the said Licensee against any and all losses or damage that might develop on account of litigation or lawsuits questioning the patent rights of the Licensor and the right of using by the Licensee.

(6) The said Licensee and its Associations agree, that in addition to the purchase price of the said machinery and chemicals, to pay to the Licensor, its successors or assigns, during the life of the contract, a royalty of one and one-half (1½) cent per box or crate, for each and every box or crate of citrus fruit and vegetables treated by said process and sold or shipped by said Licensee and associations; this price applies to all fruit treated by said process in the packing houses, in which Zeltrocide machinery has been installed.

(7) The Licensor and the Licensee mutually agree, that the Licensee shall, on or before the 10th day of each and

every month during the life of this contract, pay to the Licensor in cash or its equivalent, for all royalties due for the previous month, and along with the remittance for the previous month's royalty, shall be furnished a full and complete report and statement showing the number of [fol. 866] boxes passing through its Packing House under this agreement. In the event any litigation arises questioning the patent rights of the Licensor herein, it is mutually agreed that the said royalty of one and one-half (1½) cent per box, shall be deposited in the Citizens Bank and Trust Company of Tampa, Florida, to await the termination of said suit, and if it should be determined by said litigation that the Licensor has not infringed on any patent, the moneys so deposited shall be paid over to the Licensor, if, however, it is determined by said suit that there has been an infringement, said funds shall be held by the Licensee in said bank to answer whatever damage it may be called upon to pay on account thereof, and after paying said damage the remainder shall be paid over to the Licensor.

(8) The Licensor agrees to furnish to the Licensee, and its Associations using said machinery and formula, at the cost of the Licensor, such an inspection service as will insure to the Licensee, correct, proper and all necessary instructions, suggestions and advice in the use of the said machinery and formula, so as to insure the Licensee full benefit thereof.

(9) The Licensor and the Licensee mutually agree that the Licensor shall have two weeks notice within which to install each unit of machinery wherever needed in the State of Florida, and that not more than nine units shall be required to be installed each week after such notice, and all installations required to be made for the season of 1926 and 1927, shall be made and finished not later than February 10th, 1927.

(10) It is mutually agreed that should there be any release from the terms of this contract, such release shall in no wise affect the payment of the royalty of one-half (½) [fol. 867] of one (1) cent per box as set forth in paragraph twelve of this contract.

(11) The parties hereto further mutually agree, that should the Licensee, or any of its Associations fail to

carry out the instructions that shall be furnished by the Licensor in the application of Zeltrocide or should there be any irregularities in operating the same or in its report, the Licensor reserves the right and option to cancel this contract in regard to said Packing House or Packing Houses, or to take over and operate said machines at the expense of the Licensee, if after ten days notice to the Manager of the local Association and the Licensee herein, said irregularities are not corrected.

(12) It is further agreed, that should the patent covering the methods of application of Zeltrocide be at any time contested, so as to prevent the Licensee from using such method of application for Zeltrocide, then the Licensee shall have the right to use said machinery for any other solution in cleansing and preserving citrus fruit and vegetables as herein stated, and it is agreed that the Licensee shall and will pay to the Licensor in the manner herein-specified for the use of Zeltrocide one-half (½) of one (1) cent per box or crate for all citrus fruit or vegetables so treated, as provided in paragraph ten of this contract.

(13) The Licensor and the Licensee herein further mutually agree, that this contract shall be extended for seven additional years after the expiration of this three (3) year term, the price to be paid during said extended period of time for the use of the formula and chemicals and the cost of such chemicals, shall be agreed upon at the time of such renewal, provided, that the royalty charge shall not exceed [fol. 868] one and one-half (1½) cent per box.

(14) The Licensee and its Associations herein agree, to furnish to the Licensor a full monthly report, as designated in paragraph 7, and should the Licensee fail, neglect or refuse to furnish said report, then the Licensor may have the books of such Association so in default, audited at the cost and expense of the Licensee, for the purpose only of obtaining an accurate report of the number of boxes treated by this process by said association and for no other purpose.

(15) It is further agreed, that any and all contracts now held by the Licensor with any Association affiliated with said Licensor, may be taken up and converted into a contract as comprehended by the terms of this agreement.

(16) The Licensor shall immediately upon any inspection being made mail to the Licensee a copy of each and all inspection reports made by the Licensor or its agents.

(17) It is further agreed that if the patent for said formula, or the application thereof, shall be rejected, or it is found that the same are not patentable, then this contract is to be terminated. And all machinery purchased by the Licensee under the terms of Paragraph 2 hereof shall, upon payment being or having been made in full for the same, be the absolute property of the Licensee, provided, however that in the event this paragraph becomes effective, that Paragraph 12 shall apply and become operative and the said Licensee shall pay one-half (½) of one (1) cent per box or crate for all citrus fruit or vegetables which are treated with the machinery to be installed as aforesaid, as provided in paragraph ten of this contract, provided the Licensor holds patents on the application of the process [fol. 289] mentioned and the continuance of its use by the Licensee would constitute an infringement upon its rights upon said patent.

(18) The parties hereto further mutually agree, that this contract is made subject to strikes, embargoes, wars, freezes or other causes, which prevent either of the parties hereto from carrying out and fulfilling this part of said contract.

(19) It is mutually agreed that in case there are any liens of any kind on any of the machinery purchased by the Licensor and sold to any Association under this contract, the Licensee may upon demand of the party holding said lien pay off the same, and may retain and hold all payments due or to become due to the Licensor until said liens are fully paid off.

(20) It is further agreed, that the Licensee has the right and privilege of cancelling or terminating this Contract, Licensee or Lease at any time the services rendered by Licensor is not satisfactory to said Licensee, unless the Licensor shall within thirty days after receiving notice thereof make such services satisfactory to the Licensee.

In witness whereof the parties hereto, through its officers, have caused these presents to be executed in its name, at Tampa, Florida, this 18th day of November, A. D. 1926.

Zeltrocide Chemical Corporation, by H. Grady Zellner, President. Attest: E. L. Cordery, Secretary.
Florida Citrus Exchange, by E. L. Wirt, President. Attest: O. M. Felix, Secretary.

[fol. 870] State of Florida,
County of Hillsborough:

Before me the undersigned authority, personally appeared H. Grady Zellner and E. L. Cordery, to me personally well known and who acknowledged to and before me that they executed the foregoing instrument, for and on behalf of the Zeltrocide Chemical Corporation, a corporation, as its President and Secretary respectively, for the uses and purposes therein expressed.

In witness whereof I have hereunto set my hand and official seal, at Tampa, County of Hillsborough and State of Florida, this 26th day of November, A. D. 1926.

Grace Pemberton, Notary Public. My commission expires Dec. 24, 1927.

State of Florida,
County of Hillsborough:

Before me the undersigned authority, personally appeared, E. L. Wirt and O. M. Felix, to me personally known and who acknowledged to and before me that they executed the foregoing instrument, for and on behalf of the Florida Citrus Exchange, a corporation, as its President and Secretary respectively, for the uses and purposes therein expressed.

In witness whereof I have hereunto set my hand and official seal at Tampa, Hillsborough County, Florida, this 18th day of November, A. D. 1926.

Wm. T. Covode, Notary Public. My commission expires June 15, 1930.

[fol. 871] For valuable consideration, the undersigned Association of the Florida Citrus Exchange, hereby accepts the terms of the foregoing contract, and agrees to be substituted as the Licensee herein during the life of this con-

tract and that it will be bound by each and all the terms of said contract.

Dated at———, County of——— and State of Florida, this ——— day of November, A. D. 1926.

By ——— ——, President.

Attest: ——— ——, Secretary

Schedule A.

Part 1.—United States Patent Applications

Serial No.	Date filed	Subject
24,829	April 21, 1925	Process and composition for treating fruit.
104,043	April 23, 1926	Process and apparatus for treating fresh fruit and vegetables.
104,144	April 23, 1926	Combined dryer and polisher for fruits and vegetables.

Registered trade-mark Zeltrocide, No. 26,589.

Part II.—Foreign Applications

Great Britain, Application to be filed.
Spain, Application to be filed.
Australia, Application to be filed.
South Africa, Application to be filed.
Palestine, British Patent to be registered.

[fol. 872] NOTE.—The applications in the case of Great Britain, Spain, Australia and South Africa are to be based on the first two American cases and the trade mark, if used.

Any further patents or applications thereof on improvements or any formulas or machines, as such applications are made and numbers issued by United States or any other Countries Patent Office, are to be forwarded to the Licensee to be attached to and form a part of this Schedule.

Upon motion made, seconded and duly carried, it was moved that the Agreement be approved and accepted and that the President and General Manager be instructed to make any additional clauses or changes they deem neces-

sary to protect the interests of the Florida Citrus Exchange.

Upon motion made, seconded and duly carried, it was moved that the assessment of $1.00 per car for the Growers & Shippers League be deducted from each Account Sale by the Tampa Office.

A resolution adopted by the Growers and Shippers League to be presented to the Horticultural & Agricultural Congress at Miami, Florida, on December 6, 1926, was read by the Chairman and upon motion made, seconded and duly carried, it was moved that the Executive Committee endorse this resolution in principal. The resolution in concise form is as follows:

Whereas: The successful development of any state depends upon manufacturing or agriculture and horticulture, and

Whereas: Two of the chief industries of the state of Florida are its agriculture and horticulture, and

[fol. 873] Whereas: It is fundamental that the success of any industry must depend upon the ability of that industry successfully to market its product in competition with other sections producing the same commodities, and

Whereas: There is proposed or published from time to time by the carriers various tariffs, rules and regulations affecting the cost of marketing and distributing individual commodities, and classes of fruits and vegetables, some of which in the past have proposed penalties ag-regating millions of dollars, and

Whereas: It is impossible for one individual, association or firm to provide sufficient trained experts to analyze or funds to successfully oppose, when necessary, unjust or unreasonable penalties imposed on these industries, and

Whereas: The Growers and Shippers League was organized in 1923 by the majority of producers and shippers of fruits and vegetables for the purpose of looking after the larger traffic problems of the citrus fruit and vegetable industry and to continuously watch for changes in rates, rules or regulations adversely affecting the transportation or distribution of these commodities, and

Whereas: Since the organization of the League it has successfully opposed a large number of proposed rules and

tariffs containing increases in the cost of distributing citrus fruit and vegetables, among which are:

Secured reduced minima and reparation on celery shipped in short refrigerator cars.

[fol. 874] Prevented increase in box weights and carload minima on citrus fruit destined to Pacific Coast Territory.

Secured withdrawal of tariff proposing charges for the use of refrigerator cars on pre-cooled shipments of vegetables.

Prevented publication of rules requiring prepayment or guarantee of freight charges on citrus fruit and vegetables.

Prevented publication of rule permitting shipments to be billed to shippers "Order Notify."

Employed experts who made a comprehensive study of comparative transportation costs from Florida and other producing districts.

Had a complaint filed with the Interstate Commerce Commission requesting a readjustment of the present freight rate structure to all points in the United States and Canada, which, if successful will mean an improvement in distribution and the reduction by millions of dollars in present line haul rates.

Employed expect commerce counsel to protect the horticultural and agricultural interests in an investigation of refrigeration rates from Florida ordered by the Interstate Commerce Commission.

Therefore be it resolved that it is the sense of this meeting that, since the welfare of the horticultural and agricultural interests of Florida depends on adequately and properly safeguarding these interests against the imposition of unjust or unreasonable transportation rules, regulations or tariffs, and on placing the producers and shippers of agri- [fols. 875 & 876] cultural and horticultural products on a transportation equality as near as may be with other producing districts; it is felt these things can best be accomplished by the cooperation of agricultural and horticultural producers in support of the Growers and Shippers League of Florida, the present central agency organized to accomplish these purposes and which has already done so much in the protection of transportation interests of the producers of the state.

DOWNING'S GROCERY AND MEAT MARKET

...EZ CO. Rialto, Calif. 1 5 192 5

...to Realto Heights Co

4 Box Pow 1 20

18

THE MAN WHO PAYS HIS BILLS

By Edgar A Guest

Men could not live without him,
All dreams are wreathed about him,
A vital place he fills;
He keeps alive ambition,
Spurs progress on its mission,
The man who pays his bills.

Reprinted by permission of Mr. Guest's publishers, Reilly & Lee, Chicago
Copyright, 1923

DOWNING'S GROCERY AND MEAT MARKET

FRESH GOODS :: :: LOWEST PRICES

WE WANT YOUR TRADE

MANUFACTURED BY THE MIDWEST PRINTING CO., CHICAGO, ILL.

PLAINTIFF'S EXHIBIT NO. 77.

THIS IS A STATEMENT OF WHAT YOU OWE US

RIALTO, CALIF. Mar 1 192 6

Rialto Rights Assn

IN ACCOUNT WITH

BLUE GOOSE PHARMACY

Feb	1	Adhesive	1	15		
		Razors		98		
	3	Adhesive	4	20		
		Borax	9	00		
	21	Adhesive	1	50		
	22	Sponge		75		
			17	58		
		3/16/26				
		#892.				

TRY DA-RU LIVER LAXATIVE-DANDELION & RHUBARB

DOWNING'S GROCERY AND MEAT MARKET

PHONE 66 Rialto, Calif. 10-30 6 192

Sold to Rialto H. Assn.

Address		ACCT.	FORD.
1	Case M M Paint	6	72
2			
3	6 Borax Paint	1	68
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17	20		

PACIFIC COAST SALES BOOK CO., LOS ANGELES 2020

The Man Who Pays His Bills

BY EDGAR A. GUEST

Men could not live without him,
All dreams are wreathed about him,
A vital place he fills;
He keeps alive ambition.
Spurs progress on its mission,
The man who pays his bills.

Reprinted by permission of Mr. Guest's publishers, Reilly & Lee, Chicago
Copyright, 1923

DOWNING'S GROCERY AND MEAT MARKET

FRESH GOODS LOWEST PRICES

WE WANT YOUR TRADE

PLAINTIFF'S EXHIBIT NO. 79

STATEMENT

Rialto, California, Jan. 17th 1920

M. Rialto Heights Assn

IN ACCOUNT WITH

NEEDHAM BROTHERS

DEALERS IN ALL KINDS OF

STAPLE AND FANCY GROCERIES

100 South Riverside Avenue — Both Phones 30

To Bills Rendered				
		32	35	
Paid 1/30/20	4668			

NOTICE:—All accounts are 30 days. No exceptions.

STATEMENT

Rialto, California, 2-6 th 1920

To Rialto Heights

IN ACCOUNT WITH

NEEDHAM & ~~SON~~ Bros

DEALERS IN ALL KINDS OF

STAPLE AND FANCY GROCERIES

100 South Riverside Avenue — Both Phones 30

To Bills Rendered

5-45

STATEMENT

Rialto, California, 4 — 1 — 1920

M. Rialto Heights Association

IN ACCOUNT WITH

NEEDHAM BROTHERS

DEALERS IN ALL KINDS OF

STAPLE AND FANCY GROCERIES

100 South Riverside Avenue — Both Phones 30

To Bills Rendered	
Jan. acct	5 45
Paid 4/12/20 Chk. 4745	

NOTICE:- All accounts are 30 days. No exceptions.

FORM 24 2500-TRIP 6-25

ASSOCIATION COPY

Fruit Growers Supply Company

ROOM 711
CONSOLIDATED BUILDING
Address P.O. Box 530, Station C
Phone TRinity 4011

Los Angeles, Cal., 11/3/ 1926. SHOW THIS No. D 1667. ON YOUR INVOICE

To Pacific Coast Boat Co.

Gentlemen: Kindly enter the following order:

Ship to Rialto Heights Lumber Rialto *Cal.*	*Ship Promptly* Via Car

1 Tom Boat

Dating Feb. 1-1927

This order VOID if not presented and Invoiced within 7 DAYS.

Bill to FRUIT GROWERS SUPPLY COMPANY, Los Angeles Same	FRUIT GROWERS SUPPLY COMPANY By Hyatt

PLAINTIFF'S EXHIBIT NO. 80.

PLAINTIFFS' EXHIBIT NO. 81

J. B. HORRELL & A. S. BRYANT.

MACHINE FOR BRUSHING AND POLISHING FRUIT AND OTHER OBJECTS.

APPLICATION FILED JUNE 11, 1908. RENEWED MAY 11, 1909.

944,993. Patented Dec. 28, 1909.

3 SHEETS—SHEET 1.

Fig. 1.

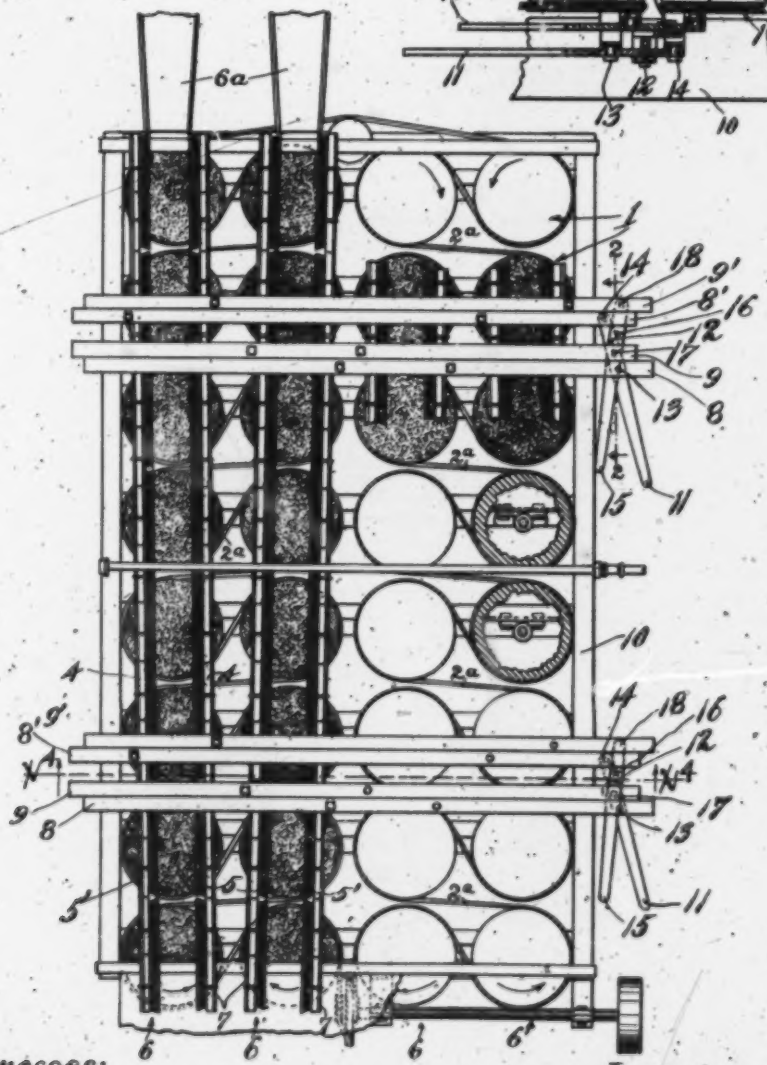
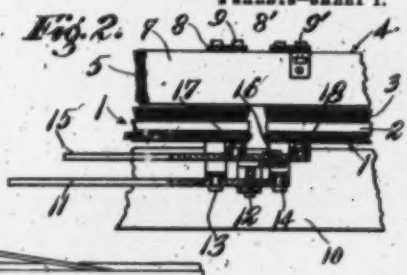


Fig. 2.



Witnesses:
C. C. Holly.
J. Townsend.

Inventors
John B. Horrell
Arthur S. Bryant
By James R. Townsend
their atty.

J. B. HORRELL & A. S. BRYANT.

MACHINE FOR BRUSHING AND POLISHING FRUIT AND OTHER OBJECTS.

APPLICATION FILED JUNE 11, 1906. RENEWED MAY 11, 1909.

944,993. Patented Dec. 28, 1909.

2 SHEETS—SHEET 2.

Fig. 3.

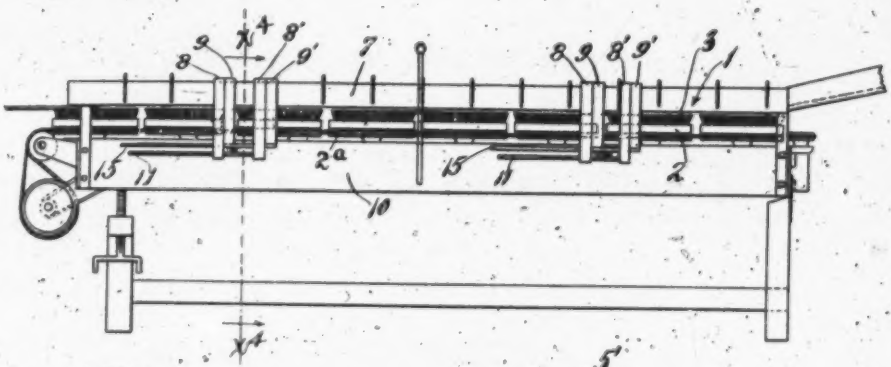


Fig. 4.

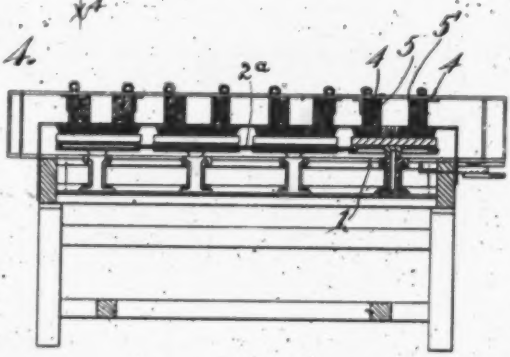
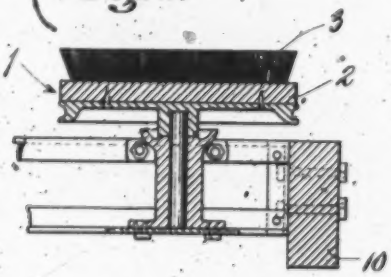


Fig. 5.

Fig. 6.



Witnesses.
C. C. Holly
J. Townsend.

Inventors
John B. Horrell
Arthur S. Bryant.
By James R. Townsend
their atty.

There being no further business to come before the Committee, upon motion made, seconded and duly carried, it was moved to adjourn.

E. L. Wirt, Chairman.

(Here follow reproductions of pages 877, 878, 879, 880, 881, 882, 883, 883a, 884, and 885)

[fol. 886] United States Patent Office

John B. Horrell and Arthur S. Bryant, of Santa Paula, California, Assignors, by Direct and Mesne Assignments to H. K. Miller Manfg. Co., of Glendora, California, a Corporation of California

Machine for Brushing and Polishing Fruit and Other Objects

944,993. Specification of Letters Patent. Patented Dec. 28, 1909

Application Filed June 11, 1906. Serial No. 321,272. Renewed May 11, 1908. Serial No. 432,319

To all whom it may concern:

Be it known that we, John B. Horrell and Arthur S. Bryant, both citizens of the United States, residing at Santa Paula, in the county of Ventura and State of California, have invented a new and useful Machine for Brushing and Polishing Fruit and other Objects, of which the following is a specification.

This invention relates to machines or apparatus for cleaning, brushing and polishing fruit and other objects; and the invention has for its object the provision of improved means or apparatus of the nature set forth which will be relatively inexpensive and simple in construction, positive and economical in operation, convenient in use and control, and generally superior in point of efficiency and serviceability.

The invention has for its specific object the provision of an improved machine or apparatus of the character described, whereby scale, dirt, or other blemishes or foreign

substances and accumulations may be removed from oranges and other fruit.

In carrying out the invention, we provide a rotary abrasive element operative substantially in a horizontal plane and other opposed abrasive elements combined with the rotary element and spaced apart to form a chute or runway which may be traversed by fruit or other objects, subject to the abrasive action of the rotary and other elements. The abrasive elements which are associated with the rotary element have straight upright abrasive surfaces facing each other; and they are preferably arranged in rows of pre-determined extent, a plurality of the rotary abrasive elements being arranged beneath the same. The horizontal elements are rotatable upon vertical axes; and the rows of upright brushes have abrasive surfaces arranged in common planes, in the respective rows. The abrasive surfaces of the rotary elements comprise a brushing or abrading floor rotating beneath the upright brushes, the latter being preferably adjustable toward and from each other and with respect to the axes of rotation of the rotary elements.

Means are employed for operating the rotary elements, and also for adjusting the rows of upright brushes, permitting adjustments of the runways between the upright rows with respect to the axes of rotation of the horizontal brushes. Preferably, it is desirable to provide and embody in one machine, a plurality of series of horizontal brushes with their associated rows of upright brushes, providing a plurality of chutes or runways, all of the horizontal rotary brushes being jointly driven from a common source of power. To the latter end, belt or rope transmission may be conveniently employed, as shown in the drawings.

As a convenient means of differentiation, the upright wall brushes may be designated as longitudinal brushes, and the horizontal rotary brushes may be designated as disk brushes. In providing a series of disk brushes, the fruit or other object is passed through the runway successively across the rotating disk brushes, which may be oppositely rotated, the fruit or other object being given a twirling or twisting movement in its path to and from the axis of rotation of each disk brush. Each part of the surface is thus

brought into frictional contact with the brushing or abrading surfaces, resulting in thorough cleaning and brushing.

The invention consists in the novel provision and construction of features and parts hereinafter described, disclosed in the drawings and finally pointed out in claims:—

In the drawings:—Figure 1 is a fragmentary plan view of means or apparatus embodying the invention, parts being omitted and shown in section for clearness of illustration; Fig. 2 is a detail sectional view, taken upon the line 2—2, Fig. 1; Fig. 3 is a side elevation of the means or apparatus shown in Fig. 1, upon a reduced scale; Fig. 4 is a transverse sectional view, taken upon the line x^4—x^4, Fig. 1, and looking in the direction of the appended arrows; the showing being partly in section; Fig. 5 is a transverse sectional view of one of the upright brush walls; and Fig. 6 is a detail sectional view of one of the horizontal rotary brushes and the associated parts and features. Figs. 5 and 6 are upon an enlarged scale.

Corresponding parts in all the figures are designated by the same reference characters.

Referring with particularity to the drawings, 1 designates disk brushes each comprising a body 2 having a brush surface 3 forming the floor of a chute, the side walls of which are formed of bodies 4 having brush surfaces 5, 5′, [fol. 887] which face each other and extend across the top of the rotary brush 1. Preferably, the rotary brushes 1 are arranged in rows 6 of desirable length, the brushes being placed close enough together to prevent objects from falling between the rotary disk brushes as they pass down the chute formed by a row of rotary brushes and the transversely-arranged brushes 5, 5′. Desirably, the transversely-arranged brushes 5, 5′, are detachably mounted on bars 7 which are carried by adjusting frames 8, 8′, 9, 9′, transversely of the machine and of said bars and chutes, and are adapted to shift the wall brushes 5, 5′, of each chute independently of each other, so that the chute may be increased and decreased in width, and the way or opening thereof between the wall brushes may be shifted with relation to the axis of rotation of any or all of the rotary brushes to which the chute pertains.

In Fig. 1 the wall brushes form two chutes, each having eight rotary brushes to form its floor, and the machine shown is adapted to employ two other rows of rotary

brushes, one of which rows is shown, and the bodies of the brushes of the other row are shown devoid of their brush surfaces, the parts also being sectioned to show construction.

10 is the frame of the machine.

11 is a shifting lever pivoted by a pivot 12 to the frame 10, and by pivots 13, 14, to the shifting frames 8, 8', respectively.

15 is a shifting lever pivoted by a pivot 16 to the frame 10, and by pivots 17, 18, to the shifting frames 9, 9'.

From the description it will appear that as the fruit is fed into the runways formed by the revolving brushes and the brush walls, the fruit is alternately acted upon by the brush surfaces and cleansed of all scale and dirt which is usually found on fruits. The rotation of the disk brushes operates to impart a forward travel to the fruit over the same by centrifugal force which could not be otherwise obtained were it not for the fact that the walls are capable of being shifted beyond the point of center of said disks or disk brushes, whereby the fruit is projected forwardly irrespective of the fact that the runways are on an incline. The inclination of the runway is immaterial since it is obvious that the action of the brushes is sufficient to propel the fruit forward until discharged at the outlet.

The straight parallel bars 7 and brushes 5, 5', carried thereby, form open ended runways extending across and terminating at the extremities of the abrasive floor comprising the brushes 3. Disks 2 are provided on the opposite side brushes 3, having means for rotation thereof, which may comprise, as shown a continuous rope drive 2^a. At the end of each longitudinal runway is provided a discharge opening or chute 6^a; and the fruit or other objects traverse the runways to said discharge openings in the directions indicated by the arrows adjacent to the rows 6 in Fig. 1.

The operation, method of use and advantages of the improvements constituting the invention will be readily understood from the foregoing description, taken in connection with the accompanying drawings and the following statement:—Any prime mover or source of power may be utilized to energize the rope drive 2^a, causing rotation of the horizontal floor brushes or disk brushes 1. The fruit is fed to the runways between adjacent rows 6 of the upright or wall brushes, and in said runways violently agitated simul-

taneously with its propulsion longitudinally of the respective runway, resulting in subjection to effective treatment by the rotary horizontal and fixed upright brushes. The fruit or other objects finally emerge through the discharge openings or chutes 6ª in thoroughly cleansed and polished condition. By means of the shifting levers 11 and 15 the shifting frames 8 and 8′ and 9 and 9′ may be manipulated to vary the positions of the rows of upright wall brushes, with respect to the vertical axes of the horizontal disk brushes 1. The courses taken by the fruit or other objects through the runways, may thus be varied, and the nature of the abrasive action of the brushes thereon altered as required.

What we claim and desire to secure by Letters-Patent of the United States is:—

1. Mechanism of the character described, comprising a rotary abrasive element operative substantially in a horizontal plane; and other opposed abrasive elements combined with said rotary abrasive element and spaced apart to form a runway extending in a chord of an arc over said rotary abrasive element whereby objects may traverse said rotary abrasive element subject to abrasive action of the entirety.

2. Mechanism of the character described, comprising a plurality of rotary abrasive elements operative substantially in a horizontal plane; and other abrasive elements having upright straight opposed abrasive surfaces arranged to form a runway extending in a chord of an arc over said rotary abrasive elements whereby objects may traverse said rotary abrasive elements subject to abrasive action of the entirety.

3. A fruit cleaner comprising a disk having a brush upon one face, guides above said face terminating on opposite sides thereof to form an open-ended runway across said brush, and means for rotating said disk.

4. A fruit cleaner comprising a disk having a brush upon one face, means for rotating said disk the same being ar- [fol. 888] ranged underneath the disk opposite the brush face to leave said face unobstructed, and guides forming an open-ended runway across said brush.

5. A fruit cleaner comprising a disk having a brush upon its upper face, means for rotating said disk consisting of a shaft projecting solely from the lower face of said disk opposite said brush, and guides forming an open-ended runway across said brush.

6. A fruit cleaner comprising a disk arranged to rotate in a horizontal plane and having a brush upon its flat upper surface, two parallel straight brushes supported transversely above said brush and terminating on opposite sides thereof to form an open-ended runway thereacross, and means for rotating said brush, said means leaving the space above the brush unobstructed.

7. A fruit cleaner comprising a row of disks having brushes upon their flat surfaces arranged to form a floor, two parallel straight brushes forming a runway across said floor and terminating in a discharge opening at one end, and means for rotating said disks, said means being below the level of the brush faces and leaving said way unobstructed.

8. A fruit cleaner comprising a disk having a brush upon one face, means for rotating said disk, guides forming a runway across said disk, said runway having an open end adapted to continuously discharge fruit, and means for shifting said runway laterally to vary its position with relation to the axis of the disk.

9. A fruit cleaner comprising a row of disks having brushes upon their flat surfaces arranged to form a floor, two parallel straight brushes forming a runway across said floor and terminating in a discharge opening at one end, means for rotating said brushes, and means for shifting said runway laterally to vary its position with relation to the axes of said disks.

10. A machine for brushing and polishing fruit, comprising a frame, brushes rotatable on a vertical axis provided with a flat upper brush surface and arranged in one or more rows, wall brushes having upright brush surfaces and arranged to form runways for said rows, respectively, adjusting frames to shift the wall brushes, and levers pivotally connected to the frame of the machine and to said adjusting frames, substantially as and for the purpose set forth.

11. A machine for brushing and polishing fruit, comprising a frame, rotary brushes arranged in a row, each being rotatable on a vertical axis and provided with an upper brush surface and wall brushes having upright straight brush surfaces and arranged to form a runway for such row.

12. Mechanism of the character described, comprising a disk brush, means for rotating said disk brush, an adjustable abrasive runway transverse of said disk brush, and means for shifting the walls of said runway.

13. Mechanism of the character described, comprising a disk brush, means for rotating said disk brush, an adjustable abrasive runway having opposed abrasive surfaces and extending transversely of said disk brush, and means for shifting said runway.

In testimony whereof, we have hereunto set out hands at Santa Paula, California, this 30th day of May 1906.

John B. Horrell, Arthur S. Bryant.

In presence of C. C. Teague, F. K. Titus.

[fol. 889] PLAINTIFF'S EXHIBIT No. 82

Western Union Telegram

Newcomb Carlton, President. George W. E. Atkins, First Vice-President

1926 Apr. 28 P. M. 12:56.

Received, Apr. 28, 1926.
CC155 115 3 Extra Blue 1/60.
Dunedin, Flo., 28 2 25P.

The Brogdex Co., I. W. Hellmon Bldg., Los Angeles, Calif.:

Please prepare for us ten boxes fruit, packing one end each box with fruit treated by Brogdex System and other end with fruit not treated. Suggest you buy five boxes from house using your process and five boxes from someone not using process and repack, using treated fruit in one end each box and unload in other end. Would suggest size one

seventy-six as being most attractive pack Period Ship one box as soon as prepared to James P. Gardner care Hanover Natl. Bank New York City, one box to J. R. Morass, care General Refrigeration Co., Beloit, Wisc. Will send shipping instructions other eight boxes in few days. Please prepay express charges.

B. C. Skinner, Skinner Mchy. Co.

[fol. 890] PLAINTIFFS' EXHIBIT No. 82-A

Western Union Telegram

Newcomb Carlton, President. George W. E. Atkins, First Vice-President

Day Letter

Received May 3, 1926.

The Brogdex Company, I. W. Hellman Compding. Los Angeles, California:

Please prepare for us ten boxes fruit packing one end of each box with fruit treated by Brogdex System and other end with fruit not treated. Suggest you buy five boxes from house using your process and five boxes from someone not using process and repack using treated fruit in one end each box and untreated in other end. Would suggest size one seventy six as being most attractive pack. Period. Ship one box as soon as prepared to James P. Gardner care Hanover National Bank New York City one box to J. R. Morash care General Refrigeration Company, Beloit, Wisconsin. Will send shipping instructions other eight boxes in a few days. Please prepay express charges.

B. C. Skinner, Skinner Machinery Company.

BCS/RC.

PLAINTIFFS' EXHIBIT No. 83

Problems in Shipping Citrus Fruits

A. R. Sandlin, Leesburg

This is a question which concerns more than the grower or shipper, for upon the final solution rests the success and prosperity of the industry as a whole, and this prosperity

[fol. 891] will naturally spread in all directions and make for better times and conditions, not only for the grower but for the grove labor, packing house labor, the banks and the transportation companies, etc.

The citrus industry has made a large growth within a comparatively short period, and with conditions promising a crop of from 15,000,000 to 18,000,000 boxes for the season of 1921-22 the growers, shippers, the many marketing agencies and the transportation companies are thinking and discussing this shipping problem as much or more than they are the further development of the industry.

The grower is beginning to realize the vital importance of growing the very best quality of fruit possible to produce in his locality; and the time is not far distant when the grower who does not grow a higher grade fruit and does not better his shipping conditions, will be compelled to abandon his grove.

With all grades of fruit, it is important and necessary that the best care possible in picking and handling the fruit from the trees to and through the packing house into the car be practiced. The once tough and leathery rind seems to be passing to a more sappy and tender condition, and this together with the many different factors that shorten the carring life of the fruit, has compelled our government and our better thinking people to set to work to better our shipping conditions. The result is bettter packing houses; better ventilation; better machinery, which is being improved from season to season; and what is probably of as much if not more importance, the pre-cooling plants are beginning to find their place where needed most. In the long warm and damp climate where we grow our fruit we can pack and cool it to that degree which will insure safe shipment under most any and all conditions.

The industry has grown to such a point that it is important that the growers and shippers keep well posted as to the daily shipments so as not to be forced to use improper cars until the transportation companies can furnish suffient [fol. 892] and proper equipment. It is also important not to pick the fruit in foggy, misty or rainy weather, which is too often done merely to hold the crews together. This invariably brings grief and especially so where a pre-cooling plant is not available.

All the above requires heavy expenditures but if judiciously handled, it is an investment and not an expense and strengthens the confidence in all shipments.

Our crate material has received the most critical consideration during the past season, and rightly so, as the crates should be strong and capable of standing any reasonable punishment which is liable and will come to most any shipment. Therefore, it is necessary that the crate be made of the very best material, well stapled, and made with from four to five cement coated nails to the cleat. They should be loaded into cars, with each box on end, and tightly loaded so as to prevent shifting and breaking; with two strips on the top of the bottom tier, and with a nail in each strip to the box. The top tier should be loaded likewise, one strip to each tier and this strip should be against one side of the car and alternating for each tier. However, the safer loading would be two strips to each tier on the top with the ends of the strip in contact with one side of the car and the other to the opposite side of the car, leaving space for ventilation in each car and between each row of boxes.

As above stated, with the enormous amount of fruit to be shipped and taking into consideration the high cost of material such as boxes, nails, paper, etc., there is no doubt in my mind that the time has arrived when the lower grades of fruit will necessarily have to be shipped in bulk. During this season the packing material and labor have cost in the neighborhood of from 90 cents to $1.00 per box, after the fruit reaches the packing house, to place it aboard the cars ready for shipment. The continual flow of this lower grade of fruit from the State in this manner only adds to the cost to the consumer without helping the quality of the commodity. It is somewhat like going into a store and buying a dozen [fol. 893] eggs for 50 cents and paying the merchant a dollar for a container in which to carry your eggs home. There has been possibly more bulk shipments from the State during the past season than during all other season combined and has proven to be a successful and satisfactory method of shipment. With the fast depletion of the forests and the increasing cost of manufacturing, crate material seems to be settling on a base of higher prices than ever known except during the war and yet the law of averages should bring the prices to a reasonable figure, and especially so if the crate manufacturers will permit the business to revert

back to the old quality and on a competitive basis. The present prices only tend to make necessary the devising of some plan whereby the low grades and off quality of fruit must be handled with less expense, if the industry survives with this class of fruit.

In transporting our citrus fruit there are many problems in which we are all more or less concerned and the foremost thought in the minds of the growers and shippers is that freight rates must be reduced. The rates are evidently slated for a reduction but just how much still remains to be figured out and settled on by the shippers, transportation people and the Interstate Commerce Commission. The transportation companies are in a precarious condition for they fully realize the importance and the necessity of freight readjustment though they are not in a position to and cannot take action because they are hampered in every direction, either by the Interstate Commerce Commission or the Labor Board. Recently the Southern railroads willingly agreed to allow unlimited diversions or re-consignments, after they were convinced that this practice was not being unnecessarily used and that the service for same was figured in with the freight rates, and that the right to divert cars would reduce the claims filed against the carriers. But when the matter was submitted to the Interstate Commerce Commission it was refused.

The Labor Board in Washington has refused, and is refusing the transportation companies the privilege to reduce [fol. 894] labor on their respective lines. With the Labor Board dictating wages and the Interstate Commerce Commission dictating rates, it leaves nothing for the officials of the transportation companies to do except try to survive the situation until such time as we growers and shippers will take hold of the situation with the view of having the Labor Board removed and bring the fact before the Interstate Commerce Commission that freight rates must necessarily be in proportion to the value of the commodities transported. About 50 per cent of the gross sales of our fruit, boxes, paper, nails and labor have gone to the transportation people as freight during the past season. For the growers to produce fruit requiring from ten to twelve months to make and to invest in packing material, and then have 50 per cent of the gross sales deducted for a service of from six to ten days transportation is nothing short of suicide for

the industry and will bring conditions to such a point that transportation must necessarily be figured out in some other manner and on some other basis.

It seems to me that the time schedule of these cars in transit is also important as the transporation companies are now taking from 50 to 100 per cent more time to transport the cars to destination than they did five years ago. The more or less dilapidated condition of the equipment and cars together with the extra time for movement to destination, has caused the growers an almost inestimable loss, not only on specific shipments, but by poisoning the minds of the receivers to the extent that they fear Florida citrus fruits are weakening to such an extent that the elementary risk is more than they are willing to take, without an excessive allowance in this direction.

We must have more cars that are better equipped for the protection of the fruit in transportation, both during warm and cold weather. Our present refrigerator cars are inadequate to move the bulk of fruit and are in a very bad physical condition and are not protecting the fruit as they should; [fol. 895] neither are they holding or maintaining ice as outlined and planned by the refrigerating engineers. Statistics show that there is entirely too much difference in temperature between the first and second tiers of fruit. A car fully iced will refrigerate the contents until the ice has melted away one-third and will retain that temperature until the ice has been reduced to one-half. After that the temperature of the contents will begin to rise and with the present equipment of cars and the long distance between the designated icing stations this does not seem to be sufficient to carry the fruit between the regular icing points. Hence, we find on practically all shipments heavy extra icing charges which were necessary between the designated icing stations from the different original points of shipment.

The refrigerating car service people have placed orders for about 10,000 cars which will still be inadequate to handle the volume of fruit from the State and take care of the commodities from the other states that require refrigerator cars when our fruit is going forward. The situation has reached such a serious point that the growers on the Pacific coast are now trying an experiment with refrigerator boat shipments through the Panama Canal to the Eastern markets. Two of these shipments have already arrived and

449

POMONA, CAL. Apr 30 1926 No. 000

THE FIRST NATIONAL BANK OF POMONA 90-177

PAY TO THE ORDER OF Rialto Heights Association $ 20 95/xx

Twenty and 95/100 DOLLARS

E. V. Bauchelle

LOS ANGELES CO. CAL.

March 10, 1928

P 891A

PAY TO THE ORDER OF
The First National Bank of Rialto
RIALTO, CALIFORNIA
RIALTO HEIGHTS ASSOCIATION

The First National Bank
OF RIALTO CAL
APR 30 1926
First Cal

48

PLAINTIFF'S EXHIBIT NO. 84-A.

Apr 30 1926

Mr. J. F. Bauchelle

To Rialto Heights Assn. Dr.

Terms

Billheads No. 10

	419 lbs Oranges @ 54	20	95

CHECK | APPROVED

INVOICE No. 454
CORRECT CHECKED

CHECK No. | APPROVED

Paid 4/30/26

Mr. Mein:
Hold these bills as there will probably be other charges
Bunnick

My Commission Expires March 10, 1928

their condition was highly satisfactory. The shippers of this State are watching the experiments very closely and I understand that there is a large company in the East which is now ready to figure with the growers and shippers of this State on the transportation problem, with the view of building boats to carry such shipments, either under forced ventilation or under full iced refrigeration. If boat shipments meet their expectations and prove satisfactory to the receivers, there is no doubt that many boats will be converted and properly equipped for the handling of perishables; and if it were possible to secure reasonable rates from the different seaport points to the inland markets, it would relieve the congestion and would eventually expand into large export-
[fol. 896] shipments which we will need within a very short time. And unless the transportation people or the refrigerator car companies are more particular and come to the relief of the situation we will no doubt be compelled to encourage the water transportation in order to move the bulk of the different perishable products from our State.

If we will set to work to grow a better quality and a higher grade of fruit, using every discretion in the grade and pack, and insist upon a faster schedule and better equipment, cheaper rates and better shipping conditions, we will no doubt push forward and prosper and the industry continue to grow and expand and meet fully the expectations of all the growers who are operating and co-operating economically for the betterment of the conditions of the industry.

(Here follows reproduction of pages 897 and 898)

[fol. 899] PLAINTIFFS' EXHIBIT No. 85

Insecticides, Fungicides and Weedkillers

A Practical Manual on the Diseases of Plants and Their Remedies, for the Use of Manufacturing Chemists, Agriculturists, Arboriculturists, and Horticulturists by E. Boureart, D. Sc.

Translated from the French, Revised and Adapted to British Standards and Practice by Donald Grant, with Eighty-three Tables and Twelve Illustrations

London: Scott, Greenwood & Son, 8 Broadway, Ludgate, E. C. 1913

[The sole rights of translation into English remain with Scott, Greenwood & Son.]

P. 208: plants; stimulating in small doses blue vitriol is poisonous in large doses. It is to be remarked that blue vitriol shares this stimulating action on algæ with many other poisonous salts. Raulin remarked in 1869 that zinc and silicum salts increased the vitality of the fungus Aspergillus niger. Nägeli, Pfeffer, and Richards made the same remark on zinc, nickel, and cobalt salts, used on the fungus Aspergillus niger and Penicillium glaucum, and on the algæ Protococcus, Chroococcus, Stigeoclonium, and Hormidium. The vitality of fungi and algæ is, to sum up, stimulated by the sulphates of zinc, nickel, cobalt, iron, and copper, mercuric chloride, sodium fluoride, lithium nitrate, potassium arseniate. The right dose for algæ is smaller than for fungi. For blue vitriol the maximum dose is 0.012 per cent; for mercuric chloride 0.0013 per cent. Ferments (leavens) behave in the same way as fungi. According to Krüger the alcoholic fermentation of wort by Saccharomyces ellipsoides is favoured by doses of blue vitriol smaller than 0.01856 per cent. Pichi and Rommier found that a solution containing 0.015 per cent of blue vitriol [fol. 900] began to impede fermentation and that 0.03 per cent reduced it perceptibly. Besides copper salts are precipitated by fermentation, the ferments can thus find in the lees the amount of copper favourable to their development (Viernacki and Krüger).

There are however, exceptions amongst plants. Thus the fresh-water algæ spiragyra dies in a solution containing only 0.000001 per cent. of blue vitriol (Nägeli), whilst other algæ resist solutions of 0.012 per cent perfectly. Penicillium glaucum would even be capable of growing in a concentrated solution of green vitriol. This fact, remarked by Trabut, was examined by De Seyes. In a nutritive solution blue vitriol does not disturb the growth of Penicillium glaucum (Trab.) in a 9.5 per cent dose. This fact must, however, be considered in another light to understand it. It is, in fact, recognized that Penicillium glaucum can grow in a poisonous medium without feeding on its elements, but by using the medium solely as a support.

Hence this mould is perfectly capable of growing on a crystal of nitrate of silver, or is a solution of 1 per cent of corrosive sublimate. Whilst germinating spores of Penicillium glaucum in a 9.5 per cent solution of blue vitriol, De Seyes observed that growth did not occur except on the edge of the vessel, where the water of condenastion was accumulated. Saccardo stopped all growth of this fungi in a medium containing 5 per cent of blue vitriol by agitating the solution; whilst at rest growth was so normal that it formed conidiæ. Penicillium therefore does not possess a special immunity for copper salts, as had been imagined, but behaves like other fungi, and R. Otto gives the dose of 0.008 per cent as favouring its development. This dose is hardly greater than that required by Aspergillus niger, 0.004 per cent.

Action of Blue Vitriol on Parasitic Fungi.—Benedikt Prevost in 1807, discovered the poisonous action of blue vitriol on parasitic fungi. In his experiments to determine the action of boiling water on spores, he made the sensible remark that water boiled in a copper vessel alone had the [fol. 901] power to prevent spores from germinating. He then determined that it sufficed for the water to contain 1 part in 400,000 of its weight of blue vitroil to prevent the spores of rust from

P. 971: then stick the two pieces together by a glue without smell. Thus, after removing the point of one of these roots a conical hole is made in it, arsenic placed in the opening so made, and closed by the piece removed, which forms a natural plug. Place the celery so prepared in the nests. Complete success will be obtained if precaution be taken to accustom the rodents to this preparation by giving them first non-poisoned celery.

16. Arsenic Acid As_2O_5.—Preparation.—By oxidizing arsenious acid by nitric acid.

Properties.—Arsenic anhydride is a white solid. It dissolves slowly in water. It is a more violent and more rapid poison than arsenious acid.

Use.—Arsenic acid has been proposed for the disinfection of seed-corn. A powder is prepared with 9 parts of lime and 1 of arsenic acid, with which the corn kept moist is sprinkled in the proportion of 3⅓ lb. per 2¾ bushels of

grain. After twenty-four hours the seeds were dried and sown.

17. Boric Acid, B_2O_3.—Occurrence.—Occurs in nature sometimes free, sometimes combined with bases.

Preparation.—By decomposing borax (sodium diborate) by hydrochloric acid. Borax is dissolved in four times its weight of water and hydrochloric acid added to a decidedly acid reaction. Boric acid crystallises out as shining scales on cooling, is drained and washed with cold water.

Properties.—Boric acid occurs as shining scales, but little soluble in water; 4 per cent at 20° C. It is a weak antiseptic. To preserve meat for three weeks it must be steeped in a 4 per cent solution.

Use.—Kühn has examined its antiseptic power on bacteria. A 1 per cent solution does not stop their growth. A 2 per cent solution stops the growth of bacteria. Even a 4 per cent solution does not kill them. The alcoholic fermen- [fol. 902] tation of saccharine solutions containing 2 per cent boric acid is not completely arrested (Schwartz). Constantin and Dufour tried without success a 2 per cent boric acid solution to kill the mole disease of the mushroom (Mycogone perniciosa).

PLAINTIFFS' EXHIBIT No. 86

The Physiological Effect of Various Agents on the Development of Penicillium Expansion, Alternaria Solani, and Oidium Lactis

Introduction

It is well known that many chemicals, drugs and ordinary household substances possess preservative properties to a greater or less degree depending to some extent upon how they are used. In order to determine the physiological effect of some of these agents upon living matter, a series of experiments was made using three moulds, which are well known, Penicillium expansum Link, Alternaria solani (E. & M.) Jones and Grout, and Oidium lactis Fresenius. In much of the work of this nature, the tests have been made on either the low organisms, the bacteria, or the higher

forms of plants and animals, the results being necessarily confined to the bare facts of retardation or inhibition of development for the former, as they are too minute to note structural changes other than those of form, and for the latter are confined to diagnostic features, as examination of the effect on the tissues is precluded during life. In the present work the nature of the organisms selected permits of minute changes in structure being seen during life as well as the more obvious changes in kind and degree of development. In the preliminary work, a yeast was used in conjunction with the moulds, but the yeast development could not be determined in turbid solutions nor on some solid media, nor could slight changes in the microscopic structure be recorded readily by means of photomicro- [fol. 903] graphs, which were used throughout the work for permanent records and for comparison. As the elimination of this feature of the work precluded close interpretation of the results, the work on the yeast was discontinued.

The records for the experiments are given as to the effect of the different agents used in varying degrees of concentration, usually to the highest point at which growth occurred. Following is a brief description of the moulds grown under conditions which permit normal development.

Penicillium expansum Link.—The Penicillium in developing forms a white, felt-like mass, covering the medium on which it is growing. As development proceeds, the mould changes to bluish green, due to conidial development, then to olive green, finally to a darker, duller color. Thom[1] states that, "The shades of color peculiar to each species under oft repeated conditions are easily recognized and are quite reliable."

Alternaria solani (E. and M.) Jones and Grout.—Alternaria forms a white abundant growth at first, which darkens later, due to the darkening of the hyphal walls and the formation of the brown conidia. During the early stages of development, the mycelium becomes of a greyish color, due to the darkening of the reverse side of the

[1] Cultural Studies of Species of Penicillium. Bull. 188, B. A. I., Dept. of Agr. 16, 1910.

mycelium, but later the whole growth becomes very dark and under some conditions wholly black.

PLAINTIFFS' EXHIBIT No. 87

File-wrapper and Contents Brogden and Trowbridge U. S. Patent No. 1,529,461, March 10, 1925, in Suit

(Not printed.)

[fol. 904] DEFENDANT'S EXHIBIT No. 1

Tabulation of Volume of Shipments of Citrus Fruit and Average Percentage of Decay for Entire Citrus Season 1924-25

(Prepared by Accounting Department, A. F. G., Inc., Orlando, Florida, Jan. 13, 1927)

Use of Borax	Packing House	Oranges		Grapefruit		Tangerines		Totals	
		Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay
	Group 1:								
No	A. F. G., Inc., Carney Grove	119⅝	.18	11½	1.06	½	2.40	132	.27
"	" " " " Crescent City, Fla.	28½	1.19	4	3.50	11½	.26	44	1.16
(*)	" " " " Maitland, Fla.	172½	1.36	95½	1.85	28⅝	.74	296	1.46
No	" " " " Lake Jem, Fla.	107⅝	1.37	33⅝	3.13	6½	4.58	148	1.91
"	" " " " Haines City, Fla.	141	.97	407	1.30	15	3.07	563	1.27
"	" " " " Cocoa Fla.	160⅜	.88	102⅝	.93	18½	.66	282	.88
"	" " " " Vero Beach, Fla.	68½	.21	85¼	.15	10⅝	00	164	.16
"	" " " " Ft. Pierce, Fla.	70⅛	.14	267⅝	.44	25¾	.51	364	.39
	Group 2:								
No	Deerfield Packing Co., Wabasso, Fla.	136⅝	.10	269½	.10	13⅜	.14	420	.10
"	Brevard Packing Co., Mims, Fla.	37⅜	1.06	31⅛	1.06	5⅜	3.10	74	1.20
"	New Smyrna Packing Co., New Smyrna, Fla.	67¼	1.88	34½	1.97	9	1.78	111	1.90
"	Goulds Growers, Inc., Fla.	0	0	122	.50	0	0	122	.50
"	Volusia Growers, Inc., Deland, Fla.	61⅜	.37	13⅜	1.45	10⅜	3.68	86	.94
"	Weirsdale Packing Co., Weirsdale, Fla.	253	.66	139¼	2.42	21½	3.65	414	1.35

DEFENDANT'S EXHIBIT No. 1—Continued.

Use of Borax	Packing House	Oranges		Grapefruit		Tangerines		Totals	
		Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay
	Group 3:								
No	Alva Citrus Growers Inc., Alva, Fla.	5½	.55	1½	4.67	0	0	7	1.43
"	Stripes Citrus Packing Co., Ft. Myers, Fla.	33½	.15	188½	.06	3	0	225	.07
(**)	The Lakeland Co., Lakeland, Fla.	96½	1.50	124½	1.43	10	2.60	231	1.51
No	I. E. Springstead & Son, Palmetto, Fla.	13½	2.92	32½	2.41	½	0	46	2.54
"	West Coast Fruit Co., Clearwater, Fla.	33	2.30	149	1.19	6	3.33	188	1.36
(***)	A. M. Klemm & Son, Winter Haven, Fla.	85½	.81	146½	.99	15½	3.45	247	1.08
"	Citra Fruit Co., Citra, Florida	103½	.89	19½	.15	17	.82	140	.78
"	Theodore Strawn, De Leon Springs, Fla.	58½	.09	9½	.00	1	0	69	.07
"	Joe Knight, Elfers, Fla.	11	.55	7	0	0	0	18	.33
"	R. H. Rice, Coconut Grove, Fla.	0	0.	365	.97	0	0	365	.97
"	R. H. Hull, Ft. Lauderdale, Fla.	1½	2.00	11½	1.83	0	0	13	1.85
		1,867½	.83	2,672	.97	229½	1.52	4,769	.94

Icing Memo. of the above total of 4,769 cars 53% or 2,527 cars were shipped under refrigeration.

Foot-notes:

(*) Borax bath was first installed at Maitland about March 1st, 1925, and was used the remainder of that season. (About month or 6 weeks.)

(**) Our present information and belief is that borax was used to some extent at Lakeland in ordinary soaking tank preceding the washer beginning in the fall of 1924, and that sometime subsequent to about March, 1925, a borax bath tank

following the washer and patterned after the one installed at Maitland was installed at Lakeland and used the remainder of that season.

Group 1.—Packing houses in this group owned and operated exclusively by A. F. G., Inc.

Group 2.—A. F. G. and Deerfield Groves Co. in partnership jointly own and operate the Wabasso house at Deerfield Packing Co. All other packing houses in this group owned and operated by separate corporations whose names are listed and in which A. F. G. owns a capital stock interest.

Group 3.—A. F. G., Inc., had no financial interest in and did not operate these houses but acted merely as marketing agent for the output, although A. F. G. brands or tradenames, such for instance as "Blue Goose," were used on the labels in conjunction with the individual packing house labels.

(***) We believe borax bath tank was installed about February 1st, 1925.

To W. B. Morton, Esq.—original and one carbon.
To R. T. M. McCready, Esq.—one carbon.

[fols. 905 & 906] DEFENDANT'S EXHIBIT No. 2

Tabulation of Volume of Shipments of Citrus Fruit and Average Percentage of Decay for Entire Citrus Season 1925-26

(Prepared by Accounting Department, A. F. G., Inc., Orlando, Florida, Jan. 13, 1927)

Use of Borax	Packing House	Oranges		Grapefruit		Tangerines		Totals	
		Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay	Number of Carloads	Average Percentage Decay
	Group 1:								
Yes	A. F. G. Inc., Carney Grove	88½	11	15	.33	1	0	104	.14
No	" " Palm Harbor, Fla.	20½	3.67	70½	1.61	3½	2.73	94	2.10
"	" " Crescent City, Fla.	27½	1.90	11½	3.55	10½	0	50	1.88
Yes	" " Maitland, Fla.	128½	.49	62½	.88	20½	0	211	.56
No	" " Lake Jem, Fla.	50½	.34	37½	.39	4½	0	92	.32
(**)	" " Haines City, Fla.	114½	1.36	228½	1.76	11	.55	354	1.59
Yes	" " Cocoa, Fla.	241½	.15	127½	.32	19½	.41	388	.22
No	" " Vero Beach, Fla.	37½	.13	70½	1.27	10½	0	118	.81
"	" " Fort Pierce, Fla.	39	.41	240	1.11	15	1.07	294	1.02
	Group 2:								
No	Deerfield Packing Co., Wabasso, Fla.	88½	.06	206½	.21	30½	0	385	.16
Yes	Brevard Packing Co., Mims, Fla.	80½	.22	42½	.33	4½	0	128	.25
"	New Smyrna Packing Co., New Smyrna, Fla.	89½	.20	46½	.15	6½	.32	143	.19
No	Goulds Packing Co., Goulds, Fla.	0	0	128	1.24	0	0	128	1.24
Yes	Volusia Growers, Inc., DeLand, Fla.	151½	.33	13½	2.19	16½	1.56	182	.68
"	Welrsdale Packing Co., Welrsdale, Fla.	192½	.37	174½	.61	13½	.60	379	.49

Group 3

Yes	Alva Citrus Growers Assn., Alva, Fla	58½	2.28	41½	3.18	2½	7.85	102	2.76
(*)	The Lakeland Co., Lakeland, Fla	63½	.39	101½	.33	6½	.79	172	.37
Yes	I. E. Springstead & Son, Palmetto, Fla	18½	3.35	48	1.75	1½	5.33	68	2.26
"	Winter Haven Growers, Inc., Winter Haven, Fla	155½	.72	328½	2.18	26	1.92	510	1.72
No	Citra Fruit Co., Citra, Fla	39½	.05	14½	.41	12	.08	66	.14
"	Estate Theo. Strawn, Deceased, DeLeon Springs, Fla	68½	.37	14½	0	2½	5.14	85	.44
(*)	Joe Knight, Elfers, Fla	18	.28	16	0	0	0	34	.15
No	Vairico Growers, Inc., Vairico, Fla	42	.95	69½	.68	8½	1.18	111	.82
		1814	.55	2190½	1.12	223½	.80	4198	.85

Icing Memo.—Of the above total of 4,198 cars 55% or 2,309 cars were shipped under refrigeration.

Foot-notes:

(*) Throughout entire season these two houses used Zeltrocide method and not borax treatment.

(**) Borax treatment installed and first used January 2, 1926. This not borax bath tank but arrangement for sprinkling fruit with borax solution following the washer. Used on oranges only January 2nd to 30th, 1926, then discontinued and resumed March 9th and continued to April 24, 1926. Used on a total of 16,124 boxes oranges only during season mentioned (approximately 45 cars).

Group 1—Packing houses in this group owned and operated exclusively by A. F. G., Inc.

Group 2.—A. F. G. and Deerfield Groves Co. in partnership jointly own and operate the Wabasso house as Deerfield Packing Co. All other packing houses in this group owned and operated by separate corporations whose names are listed and in which A. F. G. owns a capital stock interest.

Group 3.—A. F. G., Inc., had no financial interest in and did not operate these houses but acted merely as marketing agent for the output, although A. F. G. brands or tradenames, such for instance as "Blue Goose," were used on the labels in conjunction with the individual packing house labels.

To W. B. Morton, Esq.—original and one carbon.

To R. T. M. McCready, Esq.—one carbon.

1457

[fol. 907] DEFENDANT'S EXHIBIT No. 3

American Fruit Growers, Inc., Orlando, Florida.

PH-=8. October 17, 1924.

To all packing-house managers:

GENTLEMEN: Following is reproduced letter received from H. R. Fulton, Pathologist, U. S. Department of Agriculture, Orlando, Fla.:

"Experiments that we have been conducting for the past eight months show that blue mold rot can be reduced about one-half by dipping citrus fruits in a 5% borax solution at ordinary temperatures. If the temperature of the borax bath is raised to between 115 degrees and 120 degrees F., (which temperature oranges and grapefruit can stand without injury), and the soaking is prolonged to five minutes, 80% of the blue mold rot is prevented under conditions extremely favorable for its development.

"The borax treatment also reduces stem end rot 50%, and possibly more.

"A publication giving the detailed results has been delayed in press. This advance announcement is made so that Florida shippers may consider the question of trying out the treatment early in the shipping season. Please let us know about any points on which you may wish further information. The matter is still in the experimental stage but is at a point where commercial trial seems justified.

"It is requested that the matter be kept from the press for the present, until publication can be made of the evidence on which the conclusions are based."

[fol. 908] You will note that a publication giving the detailed results has been delayed in press. As soon as we have this published report we will send you this also. It might be well for you to try this out on some questionable fruit.

Yours very truly, American Fruit Growers, Inc.
F. L. Skelly, Manager.

American Fruit Growers, Inc., Orlando, Florida

PH-16. November 22, 1924.

To all packing house managers and field men.

GENTLEMEN: We received the following communication from H. R. Fulton, Pathologist, United States Department of Agriculture, which we are reproducing for your information:

"Probably you have read the article in the November 1st number of the Florida Grower on the borax treatment of citrus fruit to prevent rot. Since this was written we have gotten results from additional tests that are even more promising.

"Below are given the average results on five recent tests on precolored oranges three or four days from the tree. The fruit had been washed, graded and sized before we took the samples. It was third grade fruit, and we held it at around 70 degrees F to make the test severe. The borax solution was 5% (at the rate of one pound of borax to 2½ gallons water) and the fruit was soaked for 5 minutes. The "Cold borax solution" was at ordinary room temperature, and the "hot borax solution" was at 120 [fol. 909] degrees F. The figures give percentages for the first twelve days from taking of the samples, or from packing.

	All rots	Blue-mold rot	Stem-end rot
"Untreated	37%	7%	30%
"Cold Borax Solution	16%	1%	15%
"Hot Borax Solution	6%	0	6%

"If you wish any further information on the subject I would be glad to hear from you."

Yours very truly, American Fruit Growers, Inc.
F. L. Skelly, Manager.

FLS-lm.

Address: H. R. Fulton, Pathologist, Box 1058, Orlando, Florida.

American Fruit Growers, Inc.

PH-#19. December 3, 1924.

To all packing-houses and field men.

GENTLEMEN: Following is tabulation showing results obtained by Mr. H. R. Fulton, Pathologist, U. S. Department of Agriculture, Bureau of Plant Industry, Orlando, Florida, from samples taken of fruit being treated commercially with the cold borax spray. The results are very satisfactory considering the ease and cheapness of the treatment, after ten days use, averaging two cars per day, the borax solution showed no sign of needing renewal. Ten pounds of borax was added after every car was run to maintain the strength of the solution:

[fol. 910] "Cold 5% Borax Treatment

"Borax spray applied as the fruit left the scrubbing brushes.

"Lot 1 (Samples Taken in the Morning)

	Total rot percentages on				
Days:	3rd	6th	9th	12th	15th
"No borax treatment; washed, dried on the floor	0	2%	14%	34%	42%
"Cold borax sprayed, dried on the floor	0	0	6%	6%	6%
"Hot borax; treated in tubs, dried on floor	0	0	2%	2%	2%
"Cold borax; sprayed, dried, polished, sized (regular packing house handling)	0	0	0	8%	8%
"Lot 11 (samples taken in the afternoon)					
"No borax; washed, dried on the floor	0	2%	10%	20%	22%
"Cold borax; sprayed, dried on the floor	0	0	0	0	2%
"Hot borax; treated in tubs, dried on floor	0	0	0	0	2%

"Only a trace of blue mold showed up in the above tests. Practically all of the rot was stem end rot. It is a striking showing of effectiveness of the borax treatment in the control of this rot. The cost of this cold borax treatment in the control of this rot as carried out in this packing-house is about seventy-five cents per car. The installation was made without disturbing the machinery or interrupting the packing. The cost of the installation was about $125.00."

Yours very truly, American Fruit Growers, Inc.
F. L. Skelly, Manager.

FLS-lm.

[fol. 911] American Fruit Growers, Inc., Orlando, Florida

PH-#20. December 15, 1924.

To all packing-house managers.

GENTLEMEN: Following is circular letter sent out in regard to borax treatment by H. R. Fulton, Pathologist, United States Department of Agriculture, Bureau of Plant Industry, Orlando, Florida.

"You may be interested in the following report on an express shipment of oranges to Washington, D. C. Part of the fruit had been treated with cold 5% borax spray after washing, and was then dried, polished, graded and sized in the usual way; and part was left untreated for comparison. The fruit was third-grade, and it was held after arrival in Washington at temperatures ranging between 70 degrees and 75 degrees F., so the test conditions were more severe than in ordinary commercial shipments.

"Packed and shipped November 28, 1924, arrived Washington, D. C., December 1, 1924.

"Percentages indicate total of blue-mold and stem-end rots up to the day indicated.

"The figures in parenthesis indicate the blue mold rot alone.

"Days from Packing

	3d	6th	9th	12th
"Borax treated	0	0	7%(2%)	14%(2%)
"Untreated	0	2%	27%(5%)	60%(8%)

"This cold borax shower bath cost less than 1/5 cent per box. This installation is very simple.

"The hot 5% borax treatment (at 120 degrees F. for 5 minutes) is more effective and at the same time more expensive than the cold treatment."

Yours very truly, American Fruit Growers, Inc. F. L. Skelly, Manager.

FLS-lm.

[fol. 912] DEFENDANT'S EXHIBIT

American Fruit Growers, Inc., Orlando, Florida

Bulletin No. 5

September 13, 1926.

To all packing-house managers and field men:

All packing houses using a Borax spray or Borax bath and pending our further investigation on the subject will please make your plans for the coming season as follows:

Use water that is not artificially heated. Use a solution not over 2½%. Our understanding is that the government authorities have found this solution as effective as the 5% solution with artificially heated water.

Please acknowledge receipt of this bulletin and advise that you will conform to the above specifications. We will probably write you further on this subject in the near future and might possibly change the formula somewhat, but it is important that you make your plans to use the solution at this time as above stated.

Very truly yours, American Fruit Growers, Inc. F. L. Skelly, Manager.

FLS:P.

[fol. 913] American Fruit Growers, Inc., Orlando, Florida

Bulletin No. 8

October 12, 1926.

To all packing-house managers and field men:

You will recall that our early estimate was a loss of 2,000,000 boxes in the storm, 75% of which was grapefruit and 25% oranges. We are herewith reproducing a bulletin gotten out by H. A. Marks, Agricultural Statistician and you will not that his estimate of the loss is 2,000,000 boxes, 1,400,000 boxes grapefruit and 600,000 boxes or oranges.

"Revised Citrus Estimate"

"A revised estimate of the commercial citrus crop of Florida following the Storm damage of September 18 is for

15,000,000 boxes of which 9,000,000 boxes will be oranges and 6,000,000 grapefruit. This is a reduction of 2,000,000 boxes from the September estimate of 9,600,000 boxes of oranges and 7,400,000 boxes of grapefruit.

"Damage was heaviest in the path of the storm which destroyed the Dade County crop and caused a nearly complete loss in Lee County. On the East Coast, there was little damage from St. Lucie County north. On the West Coast, damage diminished from Lee County north but was heavy in DeSoto and Manatee Counties and extended north to southern Polk and Pinellas Counties.

"Grapefruit suffered the heaviest loss and the present estimate is for 500,000 boxes less than were shipped last season. Much of the early fruit was blown off or rendered unfit for shipment and the shortage of grapefruit will extend through the shipping season.

"Oranges suffered less damage in the storm area. The greater portion of this crop is grown in sections which were [fol. 914] not in the direct path of the storm and consequently suffered little damage. The heaviest loss in oranges was in the seedling crop. Tangerines, which are included in the orange estimate, show almost no loss.

"The commercial crop of limes which is mostly on the keys will show a loss of about two-thirds which represents the amount of the crop still unshipped at the time of the storm.

H. A. Marks, Agricultural Statistician."

Please disregard instructions regarding borax as per our bulletin No. 5 issued September the 14th. All packing houses using borax spray or borax bath will use a 1¾% solution in natural temperature of water.

Very truly yours, American Fruit Growers, Inc. F. L. Skelly, Manager.

FLS:P.

American Fruit Growers, Inc., Orlando, Florida

Bulletin No. 13

November 8, 1926.

To all packing houses and field men:

It is very important you refer again to our Bulletin No. 8 of October 12, 1926, in which we advised you to use a borax

solution of not over 1-¾% in natural temperature of water. Our experiments by using a 1-¾% solution have been that the fruit carries just as sound and remains just as sound as if treated by a higher percentage of borax solution.

Very truly yours, American Fruit Growers, Inc. F. L. Skelly, Manager.

FLS:P.

[fol. 915] DEFENDANT'S EXHIBIT No. 5

Brogden, Ricketts & Haworth Co., Engineers, Construction Managers. Fireproof Buildings. Tampa.

Our "Brogdex" headquarters is Winter Haven, instead of Tampa.

Winter Haven, Fla., Oct. 17, 1921.

Mr. A. B. Michael, Wabasso, Fla.

DEAR SIR: Enclosed a rough copy of a thing we will edit a few times and then get printed,—anyhow it is probably in such shape that you can understand what it is we are imagining. Also, enclose copy of typical contract covering the Brogdex method.

We are now very busy on Eagle Lake, Winter Garden, Leesburg, and down in Pinellas County and around Fort Myers; we got the Winter Haven house and the Florence Villa plants running fine Saturday. Both the machinery and the Brogdex worked just exactly like it did in our laboratory experiments.

We are now about 10 days behind with installations, and they are coming in faster, but we are increasing our organization and hope to be able to keep from getting too far behind. However, we must quit soliciting business in a couple of weeks or perhaps sooner and devote our energies to looking after our customers rather than trying to get more business than we can handle, and if you want to put in your Fort Pierce house or any or the others, it would be a good idea to let us know soon so that we can keep from getting in too deep by taking on too many houses in other [fol. 916] places. We consider the American one of our best prospects, and want to give them all the preference we can.

Our advertising agency is now busy with copy with a view to creating a big noise up North with the buyers and dealers,—it should appeal or be more interesting to them even than to the growers because it is the buyers and dealers that suffer most on account of fruit shrinking, shriveling, rotting, etc., and we are going to tell them what a 'bear-cat" Brogdex is and hope to be able to make it strong enough with verbal photographic and samples so that they will always look for the Brogdex sign on the box first and then for your blue gander next. We will turn loose up North in about 3 weeks, depending on how fruit gets to moving, and hope to make the demand for Brogdex fruit greater than the supply, even if we got half the houses in the state on the Brogdex band wagon.

With best wishes and hoping to get about all the American houses on the East Coast in line in the next few days, we are,

Yours very truly, Brogden, Ricketts & Haworth Co.
E. M. Brogden.

Cy. Mr. Skelly.

A Few "Brogdex" Experiments, etc.

1. Brogdex applied to lemons 2 months ago look just as they did the day they were Brogdenized, while those from the same box kept as checks have long since rotted or dried up to about the size of hickory nuts.

2. Lemons with rashers cut out nearly large enough to lay a lead pencil in and then run through Brogdex, keep just as well as if they had not been cut.

[fol. 917] 3. We have marked dozens of grape fruit with a knife, cutting the marks large enough to lay a match in, and then run them through Brogdex, and they keep just as well as if they had not been cut.

4. Brogdexed fruit does not shrink, shrivel or dry up, it remains the same condition as it happens to be in when Brogdexed, for several weeks, and even months.

5. Brogdexed fruit is just as heavy at the end of two or three weeks as it is the day it is Brogdexed.

6. Brogdex apparently disinfects or kills all the spores that cause trouble from the exterior. Rotten fruit, covered

with blue mold, can be packed with Brogdexed fruit or the rotten fruit squeezed all over the Brogdex fruit and then pack it close together for weeks without affecting the Brogdexed fruit.

7. Brogdexed fruit is waterproof and air proof. Brogdex itself will make an ordinary blotter waterproof, and is an excellent waterproofing for canvas or cloth.

8. Brogdex fruit has been kept, during August & September, in temperatures of from 100 to 110 degrees for weeks without affecting it in any way that we could see.

9. Brogdex fruit has been put in ice boxes for a few days, then transferred to temperatures of around 100, and alternated in this way for weeks, it is still with us, and doesn't look any the worse for radical change in temperature. Many others have made similar tests, particularly Mr. Carson of Frostproof.

10. It doesn't make any difference with Brogdex whether the fruit is green, ripe, or over ripe. During August we could not get any fruit except green fruit or June bloom, that was then about 14 months old, we got several boxes of [fol. 918] each from Manatee County, run it through the Brogdexer and it is still with us, looking the same as it did two months ago.

11. It doesn't make any difference whether the stem or button is pulled or not. Many series of tests have been made of Brogdexed fruit, part of it "pulled" and part clipped, we could not see any difference.

12. Expert fruit men (men who have made fortunes out of fruit and therefore evidently know the business) tell us that Brogdexed fruit improves or tastes better when a month or three weeks old than fruit not Brogdenized. In other words, a Brogdexed fruit a month old tastes as if it were freshly pulled from the tree, while the untreated fruit has naturally lost most of its flavor and freshness through evaporation.

13. The skin of a Brogdex fruit a month old is just as thick and looks like a freshly pulled fruit, while the skin of the untreated fruit a month old is very much thinner, tougher, and looks vastly different in make up.

14. Brogdex fruit a month old looks just as full and fresh as it did the day it was picked, while the untreated fruit a month old begins to look like an Indian about 100 years old.

15. Brogdexed grape fruit has been shipped to different parts of the country and re-shipped back to us at Winter Haven, it is still here and even the expert could not tell but what it was picked yesterday, yet it is over a month old.

16. Brogdex contains no harmful chemicals. It is a snow-white cold cream and would not even hurt the baby, though can't recommend it as to taste. In two hours after Brogdex is applied there is nothing left on the fruit but pure [fol. 919] para-fine and some of the natural waxes and oils taken from the citrus tree which we use in Brogdex as a preserving agent, and this is invisible except to the trained eye.

17. Brogdexed fruit is more sanitary, first, because it is waterproof and does not absorb or permit deleterious matter to stick to it, para-fine is lacking in chemical affinity, as its name denotes, and is unaffected by any of the acids or alkalies in a cold state, and is impervious to organic decay "Para-fine" is from the Latin "Para afinis," meaning lacking affinity. The solvents used in Brogdex are not only antiseptic, but act as a refrigerant, evaporating from the inside out in such a manner that none of the solvents enter the fruit. Although Brogdex does contain some of the natural essential oils and waxes of the citrus, which acts as a binder of the para-fine to the natural coating of essential oils and waxes on the fruit in its natural organic state.

18. Brogdex does not prevent or delay decay to fruit that is infected on the inside, like some of the stem end rots. In fact we sometimes think Brogdex expediates the decay of fruit that is infected on the inside, due to the fact perhaps that the spores germinate under a moist condition, and since Brogdex holds all moisture within the fruit, it is reasonable to suppose that the development takes place more rapidly. But this is to be borne in mind, that any rotten fruit will not affect or inoculate from the exterior any Brogdexed fruit.

19. Brogdex contains no bleaching or coloring agents. If the fruit is half colored when Brogdex is applied, it will remain half colored the balance of its life. We have taken Honduran oranges after they reached (perhaps three weeks in transit) run them through the Brogdexer and hold the [fol. 920] color exactly like it was when Brogdexed. They were probably green when shipped from Honduras. Florida and Porto Rico fruit, Brogdex holds the color just exactly like it happens to be when run through the machine. This feature does not particularly appeal to the early or green fruit shipper, but it is a decided protection to the buyer, he at least knows what color the fruit was when it was shipped.

20. Brogdex fruit is excellent for making marmalades, as the rind has its natural brittle texture and is easily sliced. The pure para-fine used in the Brogdex method is an excellent clarifying agent for the preserve and is skimmed off just before the sugar is added. For better marmalades, use Brogdex fruit. Recipes upon request.

21. Paragraph from typical letter from experienced citrus grower:

"I heard some reports the other day that the para-fine treatment had been tried in California, but without success because the fruit tended to spoil inside. It aroused my curiosity so much that I cut the samples you sent me and I was very much pleased to find that there was absolutely no indication of decay or spoiling in the one that was treated, while the untreated fruit certainly tasted a little bit rotten, in fact, I would not care to eat fruit with this doubtful taste; as in the case of the egg, when there is any doubt about it, there is no doubt about it, and the untreated grape fruit was certainly in a doubtful state of preservation. While the fruit treated with Brogdex was certainly in excellent shape."

—"taste" was one of the first and most often tried experiments with Brogdexed fruit.

[fol. 921] (Copy)

Contract

This agreement made this the 23rd day of September, 1921, by and between Brogden, Ricketts & Haworth Co.,

party of the first part, and Eagle Lake Citrus Growers Association, party of the second part.

Witnesseth; That in consideration of the advance of $2,000.00 and other considerations, both hereinafter mentioned, the party of the first part hereby agrees to equip and operate a laboratory and factory for the manufacture of chemical preservation for citrus fruit known as Brogdex, also to re-arrange and install certain machinery in the packing house of the party of the second part (without cost to said party of the second part), for the application of Brogdex to the fruit to be packed in said packing house; also to have this machinery and its operation supervised by a competent man (to see that the preparation is efficiently and thoroughly applied) free of expense to the party of the second part, and to supply at all times, beginning as soon as possible, the said preparation as and when needed for the preservation of fruit as and when being packed, subject to the direction of the Manager of the party of the second part.

The party of the second part agrees to pay the party of the first part the sum of ten cents a box of fruit packed in said packinghouse on which the said preparation is used, settlement to be made every two weeks.

The above mentioned advance of Two Thousand Dollars is part of the total, and is on account of the ten cents per box. In other words, two cents per box to be applied to reducing the advance above mentioned, and the remainder of eight cents a box to be paid in cash as the fruit is run through the house on which Brogdex is applied.

[fol. 922] The said party of the second part is not bound to pack all fruit in this manner; but is to be the sole judge of what fruit shall and shall not be so packed, and does not guarantee any specific amount of fruit to be so packed.

This agreement shall be in force and full effect for ten months from the date hereof.

Brogden, Ricketts & Haworth Co. Eagle Lake Citrus Growers Association.

DEFENDANT'S EXHIBIT No. 6

Frank C. Jordan, Secretary of State. Frank H. Cory, Deputy. Robert V. Jordan, Deputy

State of California,

(Seal)

Department of State

I, Frank C. Jordan, Secretary of State of the State of California, do hereby certify that I have carefully compared the transcript, to which this certificate is attached, with the record on file in my office of which it purports to be a copy, and that the same is a full, true and correct copy thereof. I further certify that this authentication is in due form and by the proper officer.

In witness whereof I have hereunto set my hand and have caused the Great Seal of the State of California to be affixed hereto this 14th day of January A. D. 1927.

Frank C. Jordan, Secretary of State, by Frank H. Cory, Deputy. (Seal.)

[fol. 923] 10¢ Revenue Stamp, Cancelled.

Articles of Incorporation of the Antiseptic Fruit and Egg Packing Company

Know all men by these presents:

That we, the undersigned, a majority of whom are citizens and residents of the State of California, have this day voluntarily associated ourselves together for the purpose of forming a corporation under the laws of the State of California.

And we hereby certify:

First. That the name of said corporation shall be the Antiseptic Fruit and Egg Packing Company.

Second. That the purposes for which it is formed are the buying of eggs, fruits and other perishable articles of food, preparing them by a new process discovered by S. Bishop, and then to place the above named food stuffs on

the market for sale. Also for acquiring by purchase or otherwise such real and personal estate as may be necessary to carry on the above described business or undertaking.

Third. That the place where the principal business of said corporation is to be transacted is San Francisco.

Fourth. That the term for which said corporation is to exist is fifty (50) years, from and after the date of its incorporation.

[fol. 924] Fifth. That the number of directors or trustees of said corporation shall be five, and that the names and residences of those who are appointed for the first year, are as follows, to wit:

Name	Whose residence is at
S. Bishop	San Francisco.
Wm. Nankervis	Iowa Hill, Placer Co. Cal.
Waldo S. Macy	Iowa Hill, Placer Co. Cal.
Harris Bishop	Iowa Hill, Placer Co. Cal.
F. W. Bishop	San Francisco.

Sixth. That the amount of the capital stock of said corporation is fifty thousand dollars ($50,000) dollars, and the number of shares into which it is divided is one hundred thousand of the par value of fifty cents each.

Seventh. That the amount of said capital stock which has been actually subscribed is fifty dollars ($50.00), and the following are the names of the persons by whom the same has been subscribed, to wit:

Name of subscribers	No. of shares	Amount
S. Bishop	Twenty (20)	$10.00
William Nankervis	Twenty (20)	10.00
Waldo S. Macy	Twenty (20)	10.00
Harris Bishop	Twenty (20)	10.00
F. W. Bishop	Twenty (20)	10.00

In witness whereof we have hereunto set our hands and seals this 29 day of September, A. D. 1900.

W. S. Macy (Seal), Harris Bishop (Seal), Fred. W. Bishop (Seal), S. Bishop, (Seal), William Nankervis (Seal)

[fol. 925] STATE OF CALIFORNIA,
County of Placer, ss:

On this 29 day of September, in the year A. D. 1900, before me, C. F. Macy a Notary Public, duly commissioned in and for said County of Placer (residing at Iowa Hill, in said County) personally appeared Harris Bishop and Waldo S. Macy, known to me to be the persons whose names are subscribed to and who executed the within instrument, and acknowledged to me that they executed the same.

In witness whereof I have hereunto set my hand and affixed my official seal the day and year last above written.

C. F. Macy, Notary Public. (Seal.)

STATE OF CALIFORNIA,
City and County of San Francisco, ss:

On the Second day of October, A. D. nineteen hundred, before me, Wm. A. Deane, County Clerk and ex-officio Clerk of the Superior Court in and for said City and County of San Francisco, State of California, personally appeared Fred W. Bishop, S. Bishop and William Nankervis known to me to be the persons whose names are subscribed to the annexed instrument, and who duly acknowledged to me that they executed the same.

In witness whereof I have hereunto set my hand and affixed the seal of the Superior Court, the day and year last above written.

Wm. A. Deane, County Clerk and ex-Officio Clerk of the Superior Court in and for the City and County of San Francisco, State of California. (Seal.)

10¢ Revenue Stamp Cancelled.

[fol. 926] STATE OF CALIFORNIA,
City and County of San Francisco, ss:

I, Wm. A. Deane, County Clerk of the City and County of San Francisco, State of California, do hereby certify the within to be a full, true and correct copy of Articles of Incorporation of the Antiseptic Fruit and Egg Packing Company as remains on file in this office.

In witness whereof I have hereunto set my hand and affixed my official seal this Third day of October, A. D. 1900.

Wm. A. Deane, Clerk, by E. M. Thompson, Deputy Clerk. (Seal.)

10¢ Revenue Stamp, Cancelled.

Endorsed: Filed in the office of the County Clerk of the City and County of San Francisco, State of California, this Third day of October, A. D. 1900. Wm. A. Deane, County Clerk, by E. M. Thompson, Deputy Clerk.

Endorsed: Filed in the office of the Secretary of State the 16th day of Oct. A. D. 1900. C. F. Curry, Secretary of State, by J. Hoesch, Deputy.

Record book 116, page 231.

[fols. 927 & 928] DEFENDANT'S EXHIBIT No. 7

United States Patent Office

Simeon Bishop, of San Francisco, California

Method of Preserving Foods

Specification Forming Part of Letters Patent No. 683,899, Dated October 8, 1901

Application Filed October 29, 1900. Serial No. 34,848. (No specimens.)

To all whom it may concern:

Be it known that I, Simeon Bishop, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Methods of Preserving Foods; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention aims to prolong the period of usefulness of fruit, vegetables, eggs, and the like as articles of food and prevent their usual rapid decay and deterioration, thereby benefitting the grower, the shipper, the merchant, and the consumer.

The invention consists in subjecting the article of food to an antiseptic bath to purify, cleanse, and kill all germ, then treating it to a coat of air-excluding material. This process not only preserves the articles of food, but enhances its value.

The article of food to be treated is first washed or bathed in a comparatively weak solution of boracic acid, which destroys any and all germs and thoroughly cleanses and renders the article wholesome. The article is then coated with gelatin, which excludes the air and prevents the entrance of atmospheric germs, thereby preventing decay. After drying the articles may be packed for shipment, storage, or other purpose, or they may be wrapped in tissue-paper rendered antiseptic by being immersed in a solution of boracic acid and then packed or stored.

The application of boracic acid is advantageous in that it prevents decay and adds to the appearance of the article and is perfectly harmless to the human system. The gelatin, besides excluding the air, also adds to the appearance of the article.

The boracic-acid solution is prepared by adding two ounces of commercial boracic acid to one gallon of pure filtered water. The gelatin is treated by dissolving one pound in a pint of pure water heated to maintain the mixture in a fluid condition.

Having thus described the invention, what is claimed as new is—

1. The method of treating articles of food to preserve and enhance their value, which consists in washing them with a solution of boracic acid and then applying a coating of gelatin, substantially as described.

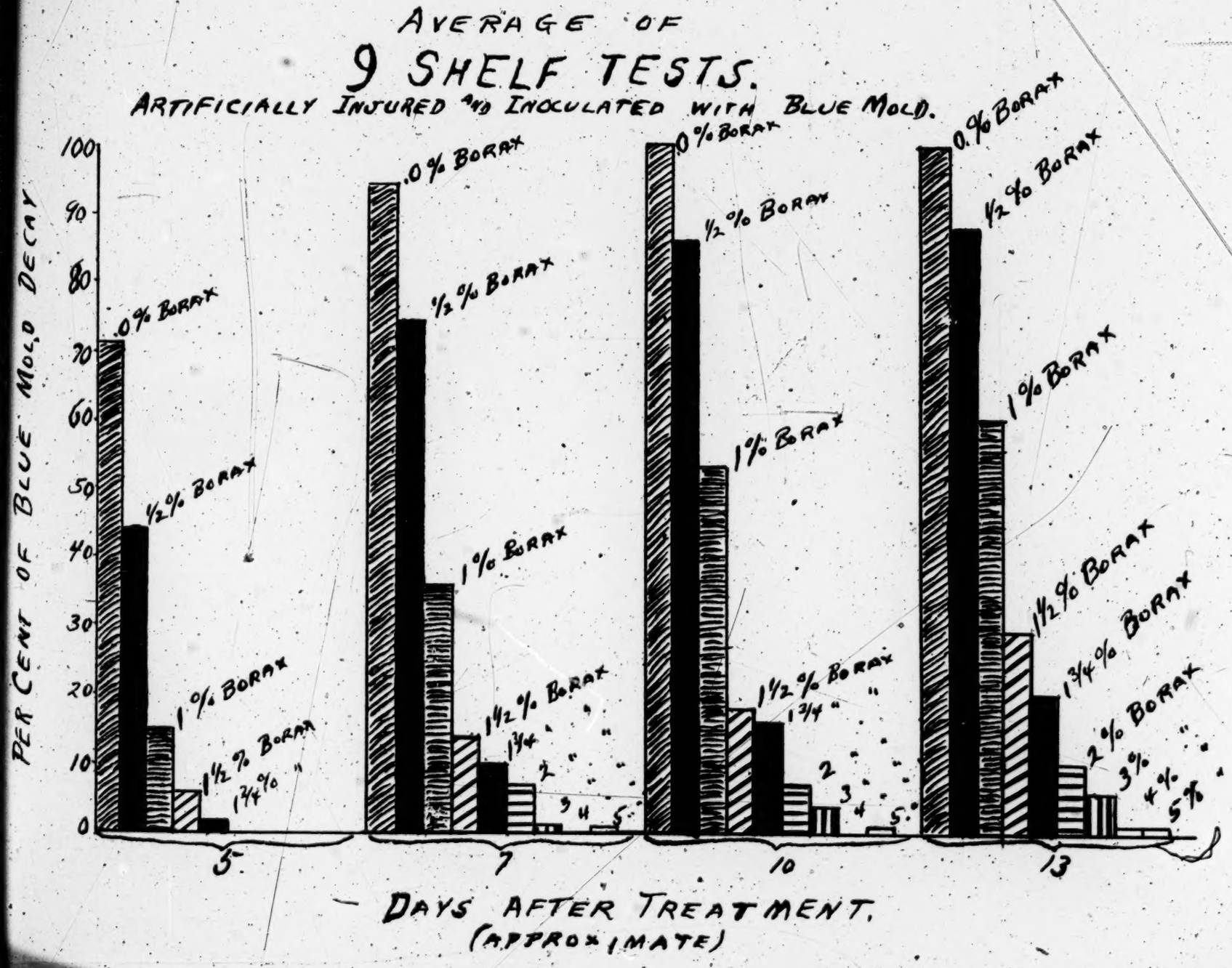
2. The method of treating articles of food to preserve and enhance their value, which consists in washing them with a solution of boracic acid and then applying a coating of gelatin, and finally wrapping the article in tissue paper which has been impregnated with a solution of boracic acid, substantially as specified.

In testimony whereof I affix my signature in presence of two witnesses.

Simeon Bishop. (L. S.)

Witnesses: Edwin W. Woodward, Leo K. Kennedy.

(Here follows Defendant's Exhibit No. 8, side folios 929 and 930)


AVERAGE OF
9 SHELF TESTS.
ARTIFICIALLY INJURED AND INOCULATED WITH BLUE MOLD.
PER CENT OF BLUE MOLD DECAY
100
90
80
70
60
50
40
30
20
10
0
.0% BORAX
½% BORAX
1% BORAX
1½% BORAX
1¾% "
2 "
3 "
4 "
5 "
3
7
10
13
DAYS AFTER TREATMENT.
(APPROXIMATE)

[fol. 931] DEFENDANT'S EXHIBIT No. 9

Department of Agriculture, Washington

January 18, 1927.

Pursuant to Section 882 of the Revised Statutes of the United States, I hereby certify that the following and annexed eight sheets are true, correct and compared photostat copies of the original records, on file in the United States Department of Agriculture, at Washington, D. C., of experiments with boric acid and oranges, conducted in the Bureau of Plant Industry of the Department of Agriculture.

Witness my hand and the seal of the United States Department of Agriculture.

R. W. Dunlap, Acting Secretary of Agriculture. (Seal.)

Boric Acid and Oranges

First Experiments Reported by H. C. Gore in Collaboration with W. M. Scott

Experiments with Boric Acid and oranges, started December 19, 1904. Four sound oranges (seeded Florida oranges) were inoculated in three places on each fruit, with a pure culture of penccillium glaucum. The abrasions into which the spores were inoculated were of three different kinds, all three kinds being used on each fruit. The kinds of abrasions made ~~were as~~ follows: a round hole about three m.m. in diameter, a stab, the blade of the scalpel being slightly twisted before withdrawal, and a cut made so as to remove a thin slice of the epidermis. In the photograph accompanying this report only the first kind of inoculation is [fol. 932] shown. The four fruits were then numbered and treated as below, and then placed under a large glass bell jar on a ground glass plate, this arrangement serving as a moist chamber.

Fruit No. 1, not treated, used as control.

Fruit No. 2, powdered boric acid was gently rubbed into the abraded parts of the skin.

Fruit No. 3 dipped in a saturated solution of pure boric acid.

Fruit No. 4, abraded parts of skin bathed with a saturated solution of pure boric acid.

Results of above experiment [five days later]*

[*Erased in copy.]

On December 24th (5 days later) it was noted that fruit No. 1 showed patches of green mold at each of the three points of inoculation. Nos. 2, 3 and 4 showed no change. By December 27th these patches on fruit No. 1 had grown larger, the other fruits being not affected. On Wednesday, December 28th fruit No. 1 was well advanced in decay, while fruits Nos. 2, 3 and 4 were unaffected except No. 2, in which the area about the inoculated points was a little shrunken. Decay may be setting in here. At this time the four fruits were photographed. On December 30th No. 1 was nearly covered with green mold, but no further change was noticed in other specimens. On December 31st, however, Nos. 2, 3 and 4 showed unmistakable evidence of the development of the fungus. No. 2 showed softening *softening* at all three points of inoculation. Nos. 3 and 4 showed softening at two inoculation points on each fruit. In both of these the stab form of inoculation has not started to go down (this form of inoculation being most protected from extraneous [fol. 933] spores.) For this reason, and also because the four fruits were kept together under the same bell jar during the time in which No. 1 was developing fungus spores in great abundance, it is believed that the decay noted in Nos. 2, 3 and 4 caused by a second inoculation of spores which came from fruit No. 1.

Boric Acid and Oranges

First Experiments Reported by H. C. Gore in Collaboration with W. M. Scott

Experiments with Boric Acid and oranges, started December 19, 1904. Four sound oranges (seeded Florida oranges) were inoculated in three places on each fruit with a pure culture of penicillium glaucum. The abrasions into which the spores were inoculated were of three different kinds, all three kinds being used on each fruit. The kinds of abrasions made were as follows: a round hole about three m.m. in diameter, a stab, the blade of the scalpel being slightly twisted before withdrawal, and a cut made so as to remove a thin slice of the epidermis. In the photograph accompanying this report only the first kind of inoculation is shown. The

four fruits were then numbered and treated as below, and then placed under a large glass bell jar on a ground glass plate, this arrangement serving as a moist chamber.

Fruit No. 1, not treated, used as control.

Fruit No. 2, powdered boric acid was gently rubbed into the abraded parts of the skin.

Fruit No. 3, dipped in a saturated solution of pure boric acid.

Fruit No. 4, abraded parts of skin bathed with a saturated solution of pure boric acid.

[fol. 934] Results of Above Experiments

(5 Days Later)

On December 24th it was noted that fruit No. 1 showed patches of green mold at each of the three points of inoculation. Nos. 2, 3 and 4 showed no change. By December 27th these patches on fruit No. 1 had grown larger, the other fruits being not affected. On Wednesday December 28th fruit No. 1 was well advanced in decay, while fruits Nos. 2, 3 and 4 were unaffected except No. 2, in which the area about the inoculated points was a little shrunken. Decay may be setting in here. At this time the four fruits were photographed. On December 30th No. 1 was nearly covered with green mold, but no further change was noticed in other specimens. On December 31st, however, Nos. 2, 3 and 4 showed unmistakable evidence of the development of the fungus. No. 2 showed softening at all three points of inoculation. Nos. 3 and 4 showed softening at two inoculation points on each fruit. In both of these the stab form of inoculation has not started to go down (this form of inoculation being most protected from extraneous spores.) For this reason, and also because the four fruits were kept together under the same bell jar during the time in which No. 1 was developing fungus spores in great abundance, it is believed that the decay noted in Nos. 2, 3 and 4 caused by a second inoculation of spores which came from fruit No. 1.

Final Results with Experiments Series I C

First Treated by the Baker Process and Kept Under Bell-jar Until January 3

Eleven fruits were removed to mailing boxes on January 3rd. After six days, 17 of the 22 inoculations had softened

down. No permanent check of the growth of the fungus is therefore shown.

[fol. 935] Exp. 1. Baker Process. Duplicate of Exp. 1, Ser. 1. I. C. Started January 3, 1905

On January 5. No changes.

On January 9.—A very slight development of the fungus was noted at five of the inoculated places, the exposed white surface of the rind showed development of white mycelia and green spores of mold, but the orange was not attacked in the usual manner by the mold.

Exp. 3. Control of Exp. 1. Also Control of Exp. 2. Started January 3

On January 9.—A very slight development of the fungus was noted at 14 of the inoculation places, the exposed white surface of the rind showed development of white mycelia and green spores of the mold, but the orange was not attacked in the usual way by the fungus.

Exp. 2. ½ Minute Dip in Saturated Boric Acid Solution. Kept in Air-tight Bell-jar. Started January 3

On January 6.—No change.

On January 9.—No change.

Exp. 4. ½-Minute Dip in ½ Saturated Boric Acid Solution. Kept in Moist Chamber. Started January 3

On January 6.—1 inoculated place had softened.

On January 7.—3 inoculated places had softened.

On January 9.—7 inoculated places had softened, of which 6 had fruited.

[fol. 936] Exp. 5. ½-Minute Dip in ¼ Saturated Boric Acid Solution. Kept in Moist Chamber. Started January 3.

On January 6.—No inoculated places had softened.

On January 7.—4 inoculated places had softened.

On January 9.—11 inoculated places had softened, of which 8 had fruited.

Exp. 6. ½-Minute Dip in ⅛ Saturated Boric Acid Solution. Started January 3

On January 6.—5 inoculated places had softened.
On January 7.—8 inoculated places had softened.
On January 9.—12 inoculated places had softened, of which 10 had fruited.

Exp. 7. Effect of Saturated Boric Acid Solution on Citrus Fruits. Started January 5

To determine whether or not boric acid solution would affect citrus fruits in any way, experiments on a wide range of citrus fruits were made.

Five kinds of citrus fruits were used, namely,—tangerine, imported lemon, Florida lemon, Indian River orange, and California navel orange. In each test, 6 fruits of each kind were employed. Of these two were held as plain checks; two were punctured in two places each, and dipped in water for ten minutes; and two were similarly punctured and dipped in saturated boric acid solutions for ten minutes. The six fruits were then held in an open mailing box.

[fols. 937 & 938] On January 6.—In case of each variety absolutely no effect of the boric acid solution was found. There was no change in color, no withering or other effect. A few very small, loosely adherent crystals of boric acid could be made out on the surface of the fruit where drops of the boric acid had dried.

Exp. 8. Effects of Inoculation with Fungus Spores on the Inoculation Places After Dipping for Ten Minutes in Saturated Boric Acid Solution

Spores were placed on the inoculation places 24 hours after dipping. Experiment started January 5. No changes are yet apparent.

Exp. 9. To Test How Far a Water Solution Will Penetrate in the Pulp of the Peel from the Surface of the Cut

Only one orange was used for this experiment. A California navel orange was cut super-cially in various places and then dipped for ten minutes in a water solution of eosin. The peel was then examined to see how far the red color had

penetrated. The soft white pulp was found to have absorbed the color to a depth of from 1 to 2 millimeters,—less than 1/16th of an inch.

Exp. 10. 10-Minute Dip of Inoculated Oranges in ½ Saturated Boric Acid Solution. Started January 6

No definite results so far, i. e., mold has not yet had time to demonstrate its characteristic attack of the fruit on the control orange. So far, some growth of the fungus appears on the control, but none appears on the dipped orange.

[fols. 939 & 940] DEFENDANT'S EXHIBIT No. 10

Some Experiments with a Boric-acid Canning Powder

Ruth B. Edmondson, Charles Thom, and L. T. Giltner

[Representation of Seal of U. S. Department of Agriculture]

United States Department of Agriculture

Department Circular 237

Washington, D. C. Issued August, 1922

[fol. 941] Some Experiments with a Boric-acid Canning Powder

By Ruth B. Edmondson, Assistant Mycologist, and Charles Thom, Mycologist in Charge, Microbiological Laboratory, Bureau of Chemistry, and L. T. Giltner, Veterinary Inspector, Bureau of Animal Industry

Contents

	Page
Canning powder examined	941
Antiseptic value of powder	942
Discussion of results	949
Summary	951

Canning Powder Examined

Among the many inquiries concerning canning problems received by the microbiological laboratory of the Bureau of

Chemistry, information as to the use of "canning powder" to supplement heat in processing has been frequently sought. These requests come from places widely enough separated to indicate that propaganda for the introduction of some sort of antiseptic in the home preservation of food is fairly widespread.

Specific inquiries supplemented by samples obtained for analysis indicated the use of a particular preparation in many sections of the country. Several series of packages of this preparation, therefore, were secured for study. Each package consisted of an envelope of white powder bearing printed directions for use. To furnish a basis for intelligent work one series of packages was analyzed.[1] The powder consisted of approximately 95 per cent of boric acid and 5 per cent of common salt, the actual divergences from this average being about one-half per cent in either direction. The net weight of 36 envelopes averaged 28.97 grams, with a minimum of 25.22 and a maximum of 34.89 grams. Evidently each package was intended to contain 1 ounce (28.34 grams) of powder. At the minimum content found, however, the loss of antiseptic powder might be great, while at the maximum content the excess of toxicity might be serious.

The directions given on the envelopes of powder called for the use of one-fourth package (one-fourth ounce) to each quart of finished material, and provided a means for the rough division of the powder into fourths. No suggestion that the use of an excess of the canning powder might be harmful was offered. Considering the difficulty of [fol. 942] estimating how much bulky fresh material would make a quart of finished or canned material, together with the haphazard method of measuring the powder and the wide range of variation found in the contents of the packages, the quantity of the canning powder actually used in successive lots of food would be variable enough to lower its antiseptic value, or, possibly, if in excess, to affect the consumer.

---

[1] The chemical work was done by J. I. Palmore, of the food control laboratory of the Bureau of Chemistry.

Antiseptic Value of Powder

Test-tube Experiments

To obtain some measure of the antiseptic value of the powder at the minimum, average, and maximum concentrations, as indicated by the actual content of the packages, standard culture media were made containing the canning powder in such quantities as to make a concentration of 0.63, 0.724, and 0.872 per cent (one-fourth package per quart), respectively. These were inoculated, together with controls on the same media without the powder, with cultures of various bacteria and a yeast. Daily observations of the cultures were made for a period of one week. The organisms chosen (Table 1) represent certain large groups commonly found in contaminated or spoiled products and are significant in considering the soundness or safety of food supplies.

Table 1.—Bacteria and Yeast Used for Inoculations

Organism	Source
Bacterium aerogenes	Italy.
Bacterium coli	Fecal strain from ripe olives.
Bacterium enteritidis	Jordan.
Bacterium paratyphosum A	Mears.
Bacterium paratyphosum B	Rowland.
Bacterium typhosum	Mears.
Bacterium suipestifer	Krumwiede.
Proteus vulgaris	Rettger.
Staphylococcus aureus	Rettger.
Streptococcus lacticus	Ayers.
Streptococcus pyogenes	Rettger.
Bacillus mesentericus ruber	Le Fevre.
Bacillus mesentericus niger	Le Fevre.
Bacillus subtilis	Le Fevre.
Bacillus botulinus Type A	Boise strain.
Bacillus botulinus Type A	Memphis strain.
Bacillus botulinus Type B	"District" strain.
Bacillus sporogenes	Savage.
Bacillus sporogenes	Mullet strain.
Bacillus putrificus	Rettger.

Organism	Source
Bacillus stearothermophilus	Donk.
Bacillus bulgaricus	Sherman.
Bacillus acidophilus	Rettger.
K-5 (bacillus from pickle brine)	Le Fevre.
Pink yeast	Hunter.

[fol. 943] At the minimum concentration (0.63 per cent) the canning powder exhibited a selective antiseptic action on the growth of these organisms. Of the 25 organisms tested the powder prevented the growth of but three (the yeast, Proteus vulgaris, and B. stearothermophilus). All but one (B. stearothermophilus) of these three are aerobic and non-spore-forming and would be killed in any ordinary process of canning. The behavior of B. bulgaricus, B. acidophilus, and the pickle bacillus is interesting. Their growth was prompt, while that of Streptococcus lacticus was inhibited until the fourth day. The growth of the remaining organisms was but slightly less abundant on this medium than on the control. It is significant that not only was the growth of none of the resistant anaerobic spore-forming bacteria stopped by the powder, but in the medium containing the powder it was as luxuriant as in the control medium. The toxin-producing powder of B. botulinus makes this especially important.

With the average concentration of the canning powder (0.724 per cent) the results were similar to those obtained with the minimum concentration, in that the growth of certain of the aerobic organisms (B. mesentericus niger, Bact. aerogenes, Bact. typhosum, Bact. paratyphosum A and B, Staphylococcus aureus, Stretococcus lacticus, the yeast, and B. acidophilus) was slightly inhibited and that of a few (B. subtilis, Proteus vulgaris, Bact. coli, B. stearothermophilus, Bact. enteritidis, and Bact. suipestifer) was entirely prevented. The resistant anaerobic species, however, were not affected, even to the extent of having their growth noticeably checked.

Practically the same results were obtained at the maximum concentration (0.872 per cent)) except that more of the aerobic organisms (B. mesentericus niger, B. subtilis, B. stearothermophilus, B. acidophilus, Bact. typhosum,

Proteus vulgaris, and the yeast) were checked and those that were not (B. mesentericus ruber, Bact. aerogenes, Bact. coli, Bact. enteritidis, Bact. suipestifer, Bact. paratyphosum A and B, Streptococcus pyogenes, Streptococcus lacticus, Staphylococcus aureus, B. bulgaricus, and the pickle organism) grew more slowly than at the lower concentrations. As before, the anaerobic species were not affected by the presence of the canning powder.

Fifteen cultures (B. mesentericus niger, B. mesentericus ruber, B. subtilis, Bact. aerogenes, Streptococcus pyogenes, Proteus vulgaris, Bact. typhosum, Bact. coli, the yeast, B. stearothermophilus, 2 strains of B. sporogenes, and 3 strains of B. botulinus) were tested with three times (2.172 per cent) the average concentration (0.724 per cent) of canning powder recommended, with the result that the growth of all but two (B. mesentericus ruber and Bact. [fol. 944] aerogenes) of the organisms was prevented, and the growth of these two was meager and slow.

Since the growth of B. botulinus was not inhibited in the foregoing experiments by the minimum, average, or maximum concentration of the canning powder, a standard medium containing the powder in concentrations varying from 0.8 to 2 per cent was made and a number of strains of B. botulinus (Laboratory Nos. 619, 621, 622, 623, 626, and 629, respectively) and B. sporogenes (Savage and Mullett) were grown in it. Daily observations were made as before for a period of two weeks. None of the B. botulinus strains were prevented from growing by even 1 per cent of the canning powder. One strain (619) grew slowly at that concentration, but growth was clearly evident on the ninth day after inoculation. Two strains (623 and 626), which grew in the presence of 1.5 per cent of the powder, did not begin to grow until the fourth day. The B. sporogenes strains grew well at this concentration of 2 per cent, however, restrained all the B. botulinus strains, as well as the B. sporogenes strains. Although these concentrations are much higher than those advocated for use in actual canning, the results obtained with them are significant in that any sense of safety from food poisoning founded on the use of the antiseptic is groundless, and dependence on it becomes a source of danger.

A similar series of cultures was made to test the effect of canning powder upon a group of molds. Tubes of dextrose

agar to which the canning powder had been added in percentages of 0.63, 0.724, and 0.87 were prepared and inoculated, together with controls on the same medium without canning powder.

For this purpose the following molds were used: Penicillium brevicaule, P. camemberti, P. roqueforti, P. divaricatum, P. spinulosum, P. viridicatum, P. oxalicum, P. expansum, Aspergillus flavus, A. niger (2 strains), A. oryzæ, A. fumigatus, A. terreus, A. nidulans, A. sydowi, A. repens, Acrostalagmus cinnabarinus, ephalothecium roseum, Trichoderma lignorum (?), one species of Rhizopus, Dematium, and Syncephalastrum sp., and three strains of Cladosporium.

Observations were made at the end of 3, 6, 11, and 17 days. The control cultures showed the usual colonies characteristic of each species. Twelve of these strains showed growth, but every one of them was delayed in development by the canning powder. Of these, Aspergillus niger, A. terreus, Penicillium camemberti, and Dematium eventually produced colonies characteristic of the species. Penicillium spinulosum, representing the Citromyces section of the group, P. expansum (the apple rot), P. divaricatum, two strains of Cladosporium, and A. sydowi showed more or less growth without producing the typical coloring characters within the time of observation. The Acrostalagmus [fol. 945] barely showed germination in the lowest concentration of powder. The other organisms failed to germinate in this experiment. In food canning experiments with the powder, however, an occasional mold colony was encountered and transferred to culture media. In this way Penicillium roqueforti (roquefort cheese mold) was once obtained in a cherry, Aspergillus fumigatus from tomatoes, A. flavus from peas, and one mucor from peaches. No one of these four species grew in the test-tube series of cultures, but A. flavus and A. fumigratus grew slowly in another culture experiment in the presence of 0.7 per cent of the powder. Clearly, then, the boric-acid canning powder in question has a selective effect on molds also, both in reducing the number of species which will germinate and in delaying or restricting the development of others, but it will not entirely eliminate spoilage due to certain common species of mold.

Practical Canning Experiments

To test the efficiency of the earning power under practical conditions, many of the fruits and vegetables in season were canned with it according to the directions printed on the packages of the powder and given in accompanying literature. To check the efficiency of the method of canning recommended, similar materials were canned in the same way, omitting the powder, and also by a well-known method. Wherever feasible three such series of samples for each product were prepared as follows:

Series 1: Prepared with the canning powder in accordance with directions.

Series 2: Prepared as in Series 1, but without the canning powder.

Series 3: Prepared by the so-called "one-period cold-pack" method (Farmers' Bulletin 829).

The method used in Series 1 varies slightly for the different vegetables and fruits, but is essentially that of cooking in the open kettle, with the addition of the canning powder at a particular stage in the cooking. The point at which the powder is added varies with the product and, with the exception of rhubarb, mincemeat, relishes, and pickles, is followed by a period of subsequent cooking so as to take a reasonable advantage of whatever efficiency the boric acid has as a sterilizing agent.

The products canned[1] were asparagus, cherries, corn, cucumber salad, lima beans, mincemeat, peaches, pears, peas, rhubarb, strawberries, string beans, and tomatoes. Materials were obtained in as fresh a condition as possible from the Washington City Market and were canned as soon as practicable after delivery. Pint glass jars were used as con- [fol. 946] tainers. Rubbers were tested before use, and the sealed jars were examined carefully for leaks before the products were stored in the basement of the Bureau of Chemistry.

A number of jars in each series were artificially inoculated with bacteria at the time of canning. The bacteria used

---

[1]The canning was done by Mrs. Mabel Heffner of the States Relations Service, U. S. Department of Agriculture.

were B. coli, B. aerogenes, B. subtilis, B. stearothermophilus, Proteus vulgaris, B. botulinus, and B. sporogenes. Several strains of the last two species were used. In all, 310 pints of material were canned. Of these 175 were inoculated. Of the 310 pints canned, 174 were put up with the canning powder (Series 1), and of these 98 were inoculated 46 were canned as in Series 1, but without the powder (Series 2), and 21 of them were inoculated; 90 were canned by the one-period cold-pack method (Series 3), and 56 of them were inoculated.

After being stored for from 1 to 3 months some of the jars of each product in each series were opened and examined physically and bacteriologically for signs of spoilage. A detailed record of the condition of each jar was kept. This included the condition of the jar and its contents, the H ion concentration (colorimetric method of Clark and Lubs[1]), the types of bacteria present in the juice of the material (as determined by Gram stained smears), and the types of bacteria found in aerobic and anaerobic cultures made from the material. In all, 177 jars were thus examined. The remaining jars that were not opened were examined frequently for physical evidences of spoilage, such as gas production, foul odor, and disintegration of material. The correlation between these findings and the bacteriological results was so close that for practical purposes the material could be judged as spoiled or not merely by a physical examination of the jar.

The results of the bacteriological examinations are summarized in Table 2. The word "spoiled" is applied to those jars in which there was an active growth of anaerobic bacteria. Where organisms were recovered in cultures from either uninoculated or inoculated jars in which there was no evidence of the growth of the bacteria the material was not considered to have spoiled.

[1]Clark, W. M., and Lubs, Herbert A. The Colorimetric Determination of Hydrogen Ion Concentration and Its Application in Bateriology. J. Bact., 2 (1917): 1-34, 109-136, 191-236.

[fol. 947] Table 2.—Summary of Canning Experiments

Series 1 (with canning powder)

Product canned	Number canned	Number inoculated	Number examined bacteriologically: Check	Number examined bacteriologically: Inoculated	Number spoiled: Check	Number spoiled: Inoculated
Asparagus	24	16	6	10	6	10
Cherries	12	6	2	4	..	..
Corn	12	9	1	5	1	5
Cucumber salad	4	2	1	..	..	..
Lima beans	8	6	1	3	1	3
Mincemeat	4	2	1	1	1	1
Peaches	8	5	2	4	..	..
Pears	8	5	2	3	..	..
Peas	14	8	2	4	2	4
Rhubarb	24	12	8	7	..	1
Strawberries	24	12	9	7	..	a1
String beans	20	7	8	4	5	4
Tomatoes	12	8	2	5	..	4
Total	174	98	45	57	16	33

Series 2 (without canning powder)

Product canned	Number canned	Number inoculated	Number examined bacteriologically: Check	Number examined bacteriologically: Inoculated	Number spoiled: Check	Number spoiled: Inoculated
Asparagus	..	..	..	..	..	..
Cherries	3	1	2	..	..	..
Corn	2	1	1	1	1	1
Cucumber salad	4	2	1	1	..	..
Lima beans	4	3	..	3	..	3
Mincemeat	2	..	1	..	..	..
Peaches	2	1	..	1	..	..
Pears	..	..	..	..	..	..
Peas	..	..	..	..	..	..
Rhubarb	6	4	1	3	..	..
Strawberries	6	3	1	2	..	..
String beans	11	2	6	2	6	2
Tomatoes	6	4	1	2	1	2
Total	46	21	14	15	8	8

a The inoculum (B. sporogenes) was added after cooking the product.

Series 3 (one-period cold-pack method)

Product canned	Number canned	Number inoculated	Number examined bacteriologically: Check	Number examined bacteriologically: Inoculated	Number spoiled: Check	Number spoiled: Inoculated
Asparagus	14	6	4	4	..	..
Cherries	8	4	2	2	..	..
Corn	10	6	2	2	1	2
Cucumber salad	..	..	..	..	..	..
Lima beans	8	6	1	4	..	4
Mincemeat	..	..	..	..	..	..
Peaches	6	4	1	2	..	..
Pears	6	4	1	2	..	..
Peas	10	8	2	4	2	3
Rhubarb	8	6	..	3	..	..
Strawberries	4	2	1	1	..	..
String beans	8	4	2	2	1	1
Tomatoes	8	6	1	3	..	1
Total	90	56	17	29	4	11

[fol. 948] Grouping the products canned, the following conclusions may be drawn from Table 2: None of the fruits canned by the "open-kettle" method, with or without the canning powder, or by the "one-period cold-pack" method spoiled, with the exception of an inoculated jar of strawberries and a few jars of other fruits, in which small mold colonies were found. In the case of the strawberries, the inoculum, B. sporogenes, was added just before the jar was sealed and the product received no subsequent processing. Acid products (Table 3) are usually considered to be easily preserved. The keeping of the majority of those canned in these experiments, therefore, is but the ordinary experience.

On the other hand, the more or less neutral products (Table 3) are generally accepted as being more difficult to can successfully. In one series a total of 78 cans of corn, asparagus, peas, string beans, and lima beans were packed with the canning powder, using products from the city market. As determined by physical examination, 68 of the total number spoiled. Forty-four of the 78 cans put up were examined bacteriologically, with the result that 41 showed bacterial activity. In another series of 50 cans put up by the so-called "cold-pack" method, 14 spoiled. Neither of the methods used, therefore, proved adequate to preserve these particular lots of vegetables purchased in the city

wholesale market. It is evident also that the boric acid of the canning powder failed to overcome either the natural infection or the inoculation added in the laboratory.

Of the other products studied, tomatoes put up with the canning powder but not inoculated remained sound, whereas 4 out of 8 cans inoculated spoiled. The tomatoes which received the same cooking but no powder spoiled. This gives in the case of tomatoes some support to the claim that the addition of the canning powder will permit a shortening of the cooking process. Thirty of the jars of rhubarb were packed in water without cooking, according to the method recommended. Of these 24 contained canning powder, 12 of which were inoculated, while 6 were in cold water only. Of these 30 jars packed without cooking one inoculated with B. sporogenes spoiled; the remaining 29 with and without the canning powder, showed no bacterial activity. This result may be fairly attributed to the natural acidity of the rhubarb rather than to the powder. Similarly, in the cucumber salad and mincemeat the presence of a large quantity of vinegar accounts for the absence of spoilage.

Bacillus botulinus did not grow in any of the fruits canned, but it did grow and produce its toxin in most of the vegetables canned. Samples of asparagus from Series 1 (with canning powder) and Series 2 (without canning powder), which had been inoculated with B. botulinus and which showed extensive spoilage on opening, produced typical symptoms of botulism and death in guinea pigs fed [fol. 949] with 5 cubic centimeter amounts of the juice. There was no growth of the organism in asparagus canned by the cold-pack method. B. botulinus grew and produced toxin in corn, lima beans, and string beans, put up in all three series. The spoilage in these products was particularly offensive. Large quantities of gas were formed, the liquid spurted when the jars were opened, and the material was more or less disintegrated. Peas canned with the canning powder and inoculated with B. botulinus proved toxic to guinea pigs, while those canned by the cold-pack method were not toxic. Bacillus botulinus did not grow in the rhubarb, mincemeat, or cucumber salad canned. It did grow in tomatoes canned without the canning powder (Series 2) and by the cold-pack (Series 3) method, but not in tomatoes canned with the canning powder. The tomatoes were

slightly overripe when canned, and the addition of the boric-acid canning powder in Series 1 evidently protected them.

These results with B. botulinus in the canning of the so-called neutral products, which are in harmony with the results in the test-tube experiments, show that the boric-acid canning powder is not a safeguard from the type of food poisoning known as botulism or from extensive spoilage by B. sporogenes. Bacillus sporogenes is a common organism, and, according to Burke[1] and Meyer,[2] B. botulinus is more abundant than has heretofore been believed. This makes it all the more imperative that methods of canning shall be such as to eliminate, as far as possible, spoilage by these organisms, especially that of the toxin-producing B. Botulinus.

Discussion of Results

The use of canning powder is further complicated by the physiological factor of taste. Those who have condoned the use of such powder in canning have put forth the argument that the small amount of antiseptic present in a quart of food is no more harmful than the use of the common condiments which are also poisonous in quantity. They have failed to emphasize the fact that condiments by their taste alone give ample warning to the consumer long before a poisonous concentration is reached. There was practically no indication, however, of the presence of boric-acid canning powder in the foods canned in the bureau. Various members of the microbiological laboratory tasted product after product. They were aware, of course, that some contained the powder and so were more critical than they might have been otherwise. Even for them it required close attention to detect the presence of the powder in any [fol. 950] of the samples. The consumer has no protection against the use of an excess of the powder except the slight change in acidity, which becomes evident only when the excess is marked. There is, therefore, no comparison to be

---

[1]Burke, G. S. The Occurrence of Bacillus Botulinus in Nature. J. Bact., 4 (1919); 541-553.

[2]Meyer, K. F., and Geiger, J. C. The Distribution of the Spores of B. Botulinus in Nature. Public Health Reports, 36 (1921): 4.

made between condiments and the boric-acid canning powder in this respect.

These experiments contribute little toward the controversy as to the effect of boric acid upon the consumer, although, in collaboration with the Bureau of Animal Industry, products canned with the boric-acid canning powder were shown to be deleterious to chickens (reported elsewhere).

No claim of food or condimental value has ever been made for boric acid. Antiseptic power and harmlessness in the amounts used are its sole claims to a place in any food product. Analyzed on the basis of these experiments, the antiseptic power of boric acid has not proved great. What antiseptic power it has may be due either to its influence upon acidity or to the selective effects of the boron compound upon microorganisms. Kühl,[1] Tanner and Funk,[2] Lazarus,[3] and others have also reported feeble antiseptic powders for boric acid.

To determine the relation of the canning powder to acidity the hydrogen ion concentration of the media used, both with and without the powder, was determined by the colorimetric method. In the test-tube experiments the dextrose agar had a pH value of 7 without the canning powder and of 6.5 with the canning powder. Milk had a pH value of 6.5 before the addition of the powder and of 6 afterwards. The pH value of wort broth was 5 without the powder and 4.5 with it. The acidities of the fruits and vegetables used in the canning experiments are shown in Table 3.

---

[1] Kühl, H. Boric Acid as a Preservative. Phar. Centr., 50 (1909): 559-561.

[2] Tanner, F. W., and Funk, R. S. Some observations on the Use of Boric Acid as a Disinfectant. Am. J. Pharm., 91 (1919): 206-210

[3] Lazarus, A. Die Wirkungsweise der gebrauchlicheren Mittel zur Conservirung der Milch. Zts. Hyg., 8 (1890): 207-239.

Table 3.—pH Values[a] of Products Canned

Product	Series 1 (method recommended, using canning powder)	Series 2 (method recommended, omitting canning powder)	Series 3 (cold-pack method)
Cherries	4.0	4.5	4.5
Peaches	3.5	4.0	5.0
Pears	3.5	(b)	4.5
Strawberries	4.0	4.5	4.5
Asparagus	5.0–5.5	6.0–6.5	6.0
Corn	5.5	6.0	6.5
Lima beans	6.5	7.0	6.5–7.0
Peas	5.0–5.5	(b)	6.0–6.5
Rhubarb	3.5–4.0	4.0	4.0
String beans	5.0	5.5	6.5
Tomatoes	4.5	5.5	5.0
Cucumber salad	3.5	4.0	(b)
Mincemeat	3.5	4.0	(b)

[fol. 951] From these figures it is evident that the boric-acid canning powder in the amounts prescribed produces a slight but measurable increase in acidity. Bigelow and Cathcart,[1] Weiss,[2] and others have tested the relation of acidity as measured in this way to the effectiveness of processing temperatures. Increase in acidity has been shown to be a factor in bacterial destruction great enough to assist materially in sterilizing. The experiments reported here, however, indicate with equal clearness that the cooking prescribed for use with the powder was still inadequate to produce any large percentage of sterility product by product.

---

[a] Determined for uninoculated jars at time of bacteriological examination. [b] None canned.

[1] Bigelow, W. D., and Cathcart, P. H. Relation of Processing to the Acidity of Canned Foods. National Canners' Assn. Research Laboratory Bull. 17-L (1921).

[2] Weiss, Harry. The Heat Resistance of Spores with Special Reference to the Spores of B. botulinus. J. Inf. Dis., 28 (1921): 70-92.

In the cultural tests the canning powder introduced in the medium did restrain to a certain extent the yeast, certain molds, the non-spore-forming and some of the spore-forming aerobic bacteria. Since the molds and non-spore-forming bacteria, however, do not survive any standard cooking process they appear in canned products only when totally inadequate processing periods and temperatures are used. In the authors' canning experiments these and the aerobic spore-forming bacteria do not appear as factors in loss. On the other hand, the spore-forming anaerobic organisms grew equally well in the presence of the canning powder in the test-tube and in the practical canning experiments. Manifestly neither the selective toxicity of the boron compound nor the increase in acidity as an aid in sterilization was adequate to prevent the loss. The group of organisms selected in these experiments included a series of strains of B. sporogenes, obtained in cases of extensive loss of canned food, and of B. botulinus, obtained from canned food responsible for food poisoning. The canning powder as used is seen, therefore, to fail entirely to protect the product against these two groups of organisms, which represent the most dangerous phase of spoilage in canned food.

Summary

The boric-acid canning powder in the amount recommended exerted a selective antiseptic action toward certain molds and members of the aerobic group of microorganisms in test-tube experiments. These groups are not responsible for spoilage in properly processed cans or jars, and may therefore be disregarded for the present purposes. The powder in the amount recommended for canning had no inhibitory effect on representative members of the anaerobic spore-forming group, especially the trexin-forming B. botulinus, which has recently been responsible for many deaths from food poisoning.

[fol. 952] In the practical canning experiments the use of the powder for acid products was shown to be an unnecessary and wasteful practice, since material packed without the powder kept as well as that packed with it. Its use with the more or less neutral vegetables showed that the powder plus the inadequate heating recommended was not

sufficient to preserve the materials or to prevent the production of toxin in them by B. botulinus.

Additional copies of this publication may be procured from the Superintendent of Documents, Government Printing Office, Washington D. C., at 5 cents per copy.

[fol. 953] DEFENDANT'S EXHIBIT No. 11

Bulletin of the U. S. Department of Agriculture No. 109

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief, June 11, 1914

The Molds of Cigars and Their Prevention

By R. H. True, Physiologist in Charge of Plant Physiological and Fermentation Investigations

Introduction

In 1901 a number of complaints were received from eastern cigar manufacturers to the effect that considerable losses were being sustained through the appearance of moldy growths on the finished products. These growths in some cases appeared within about three days after the manufacture and the boxing of the cigars, thus frequently being noticed before they left the factory. In some instances, however, they did not appear until after considerable periods of time. If the mold was detected before the cigars left the factory, the only recourse was to wipe

NOTE.—This paper discusses the losses due to the development of molds on cigars, outlines the studies directed toward the prevention of them, and presents practical directions for the use of an effective remedy. The molds were found to be introduced principally through the gumtragacanth paste used to fasten the small flap at the head of the cigar. The sterilization of the paste by using a nearly saturated solution of boric acid instead of water in mixing it has proved so successful that it has become a routine process in the factory in cooperation with which the investigations were conducted.

[fol. 954] off the growth by hand, a rather expensive process. Perhaps equally objectionable results followed when the mold was not discovered until the cigars were in the hands of the buyers. In either case very considerable loss was likely to result.

The writer was asked to study the problem and, if practicable, to work out feasible means by which the trouble could be remedied. Several factories in which this trouble appeared were visited, managers were consulted, and materials for further work were obtained.

Factory Conditions

In order to get light on the conditions to be dealt with, the processes involved in making the brands of cigars most liable to mold were observed in the factories. In the case of one factory more difficulty was experienced with Sumatra wrappers than with other sorts, and the trouble was believed to be worse in rainy seasons than at other times. The mold usually appeared most abundantly on the "head," or closed end of the cigar, less frequently on the veins or other elevated portions of the wrapper, but in some cases the entire surface was more or less involved.

The wrapper leaf is usually prepared for use the day before it is actually used in manufacture. It is first brought into the necessary moist condition, or gotten into "case," by dipping into water. The leaves are bound into small bundles in which the bases of the leaves are tied together. These bundles, or "hands," are grasped by their bases and carried down into and through the "casing" liquid with a scooping motion, so performed as to drag the bundle of leaves with the bases ahead, the blades of the leaves being pulled through the liquid. After this quick dip, the bundles are shaken and set upright on a draining board to permit [fol. 955] the surplus liquid to drain away. The pile, loosely packed together, is then covered with a moist cloth and allowed to stand until the droplets of water clinging to the suface of the leaves have been absorbed. In a few hours the leaf becomes soft and pliable without giving the impression of being wet. The ribs are then pulled out and the broad leaf blades are worked up as their size, shape, and quality may determine. The freshly made cigars are

then sorted according to colors and boxed immediately, or sometimes held in bundles, to be packed later.

In this condition each cigar is round, and the prescribed number of cigars when placed in the box overfill it, so that the cover must be brought into place by the use of pressure. Here the moist cigars yield to each other and take on such flattened sides and angles as may be required to get the box closed. Sometimes the lids of the boxes are considerably bent by the pressure of the fresh cigars, and the boxes are then placed for a day in large presses before they are nailed up. In warm weather the mold sometimes appears while the boxed cigars are in the presses; that is, within 48 hours after they are made, but more frequently within a week or two after making. When warm, humid weather conditions prevail it is not rare for molds to appear while the cigars are in transit or in storage. Since heat and moisture are necessary conditions for mold development, it follows that little trouble is experienced in the winter months but much during the hot summer months.

A number of attempts had been made by the factory managers to remove this source of loss. Small quantities of vinegar in the water (1 pint in 4 or 5 gallons) used for casing wrapper leaf were found to aggravate the trouble. When the leaf was cased in vinegar at full strength the molds were suppressed, but the luster of the leaf was thought to be impaired. Casing in alcoholic solutions was [fol. 956] found to be helpful, but too expensive. Small quantities of glycerine were found to be useless in suppressing molds, but helpful in retaining moisture in the wrapper.

Laboratory Investigations

Cigars on which mold had developed were obtained from several sources and submitted to examination. Two forms of molds seemed to be present—one, of most common occurrence, a small organism of grayish or whitish appearance, usually thinly scattered over the cigars, but most abundant and frequent at the head of the cigar, and the other a large organism, occurring usually near the head of the cigar in rather sharply defined patches of a dazzling white color. The latter organism was much less frequently seen.

It being evident that the factories offered favorable conditions for retaining spores of molds when once introduced, it was clear that general treatment looking toward the eradication of these organisms was out of the question, assuming that it was practicable to prevent the entrance of new infections on tobacco leaf and other materials brought in. The most serious localized sources of trouble were therefore sought.

Paste Used

Gum tragacanth is used in small quantity to fasten the wrapper of the cigar in place. The wrapper is rolled tightly on the cigar, the rolling proceeding from the open end toward the head, the last portion of the wrapper remaining free being a small flap of leaf which serves to finish off the head. This small flap receives a little paste on the under surface and is then carefully brought into place. The cigar is then usually rolled with some pressure between the hand and the board or table at which the cigar maker works, thus giving it the desired regularity of form. Thus, [fol. 957] a little paste is always found at the head of the cigar, and if an excess has been applied, especially if the paste is rather thin, a portion is liable to be squeezed out on the board or table at which the maker works, and the cigars may receive a more or less extensive smear of paste over the surface of the wrapper.

The paste as usually made up contains about 10 parts by weight of gum tragacanth to 90 parts of water. A large stock is generally made in one container, sometimes only enough to last for the day and sometimes enough to last for a longer period. An inspection of the paste pots in several factories showed that while some were in fairly clean condition the sides of others were thoroughly covered with molds, indicating that in some cases little attention was paid to cleanliness regarding this feature.

An inspection of the wrapper leaf in no case showed visible mold, although it is a matter of common observation that when tobacco leaves are kept sufficiently moist in a closed space they can be made to mold.

Molds in Tragacanth Gum

Tragacanth gum is usually bought in considerable quantities for use in the larger factories, and, if the samples

obtained in this investigation from several such sources were representative, the highest grades of the gum are not used. It was thought possible that these gums themselves might be carriers of molds, and several samples were set away in sterile Petri dishes to which a small quantity of sterile distilled water was added. These cultures, like others to be described, when not under observation were kept in a dark chamber in which the temperature varied between 21.5° and 25° C. n three days all the samples showed an abundant growth of molds, which began to [fol. 958] develop fruiting stages on the fourth day. For further study, cultures were transferred to a medium containing one-half of 1 per cent sodium chlorid, 1 per cent peptone, 1 per cent beef broth, and +10 points acidity. Other cultures were also prepared on sterilized tragacanth gum, partly prepared on a thick paste and partly on a thinner paste.

Cultures on beef agar and peptone flourished and yielded a variety of organisms, which were turned over for identification of Mrs. Flora W. Patterson, Mycologist of the Bureau of Plant Industry. Four forms appeared with great regularity. Most conspicuous and quickest in growth were (1) Rhizoporus nigricans Ehren., a large organism forming large, loose, conspicuous hyphal masses; (2) Mucor racemosus Fres. var. brunneus Morini, a smaller organism rapidly forming a loose, white, mass of hyphæ and (3) Penicillium sp., a somewhat slower organism in point of development, marked by its white round-headed conidiophores. This organism in the early stages was striking by reason of its brilliant whiteness, but as the cultures grew older the more usual bluish color appeared. The last common form was (4) Aspergillus candidus Link, a very small mold, characterized by its slower growth, its dingy white color, and its appearance in mixed cultures as a minute undergrowth among the above-mentioned larger organisms. No attempt was made to carry out a further study of these organisms. It seemed clear, however, that the Aspergillus was more at home on the tragacanth medium than on the beef agar and peptone as here offered.

Molds on Wrapper Leaf

As it seemed very probable that the wrapper leaves, like most other free surfaces, might give lodgment to spores of molds and thus become agents of infection, it was thought desirable to see what molds could be cultivated from them. Accordingly, cultures in the media previously described [fol. 959] were prepared from the washings obtained by rinsing the surfaces of wrapper leaves with sterile water. Several organisms were obtained in small quantities, and Mrs. Patterson identified the following: (1) Aspergillus subgriseus Pk., (2) Macrosporium commune Rabh., (3) Sterigmatocystis castanea Patters., (4) Cladosporium herbarum (P.) Link, (5) Penicillium sp. In general, the leaf surfaces were rather sterile of molds.

Molds on Cigars

Samples of moldy cigars obtained from various sources were also investigated by the method described, and the following organisms were identified by Mrs. Patterson: (1) Aspergillus candidus Link, a very small dingy white mold, occurring as a rather sparse growth on cigars, especially near the head, but frequently in diffuse growth over a considerable part of the surface, which seems to be the most often present on cigars and is probably responsible for most of the trouble; (2) Penicillium sp., a widely distributed mold, likely to appear on a great variety of substances; (3) Sterigmatocystis castanea Patters., an unusual form, not likely to be a cause of harm here; (4) Cladosporium herbarum (P.) Link, one of the molds commonly turning up on decaying vegetable matter, probably not a source of serious trouble here.

It will be seen that the organisms responsible for the most serious trouble (Aspergillus candidus, easily first in importance, and Penicillium glaucum) are not represented in the list of organisms introduced on the wrapper leaf, but seem to be always present in the tragacanth gum. The conclusion seems, therefore, to follow that in the case in hand the paste used in fastening the wrapper at the head of the cigar brought with it the troublesome organisms.

[fol. 960] Infection Experiments on Wrapper Leaf

It having been rendered probable that the tragacanth paste was inoculated with the molds from the start, the next question to be answered was that of seat of the growth of molds on the wrappers. As it has already been shown that the paste itself is a favorable culture medium for these organisms, it follows that the tobacco leaf in itself is not necessarily a favorable support for the molds. However, it is well known that moist tobacco leaves do become moldy under conditions favoring this process, and experiments were made having for their object the infection of wrapper leaves with the two species of mold last mentioned. These attempts failed to produce mold on the leaves used in the absence of any substance foreign to the leaves that might act as a source of food for the fungi.

Infection Experiments on Cigars

In view of the nature of the problem under study, the fact that cigars could be infected with molds was not open to doubt. Since it had been shown that these molds do not readily grow on wrapper leaf, it appeared probable in view of the fact that the infection was introduced with the tragacanth paste, that the growth on the cigar was confined to the paste present on the wrapper. It was thought desirable to try to check up this conclusion by attempting to grow these molds on cigars. Accordingly, repeated attempts were made to grow the organisms in question on pieces of cigars moistened and placed in sterile Petri dishes or test tubes. In some cases these pieces molded and in others they did not. Usually the piece at the head of the cigar molded without difficulty, while those portions from other parts of the cigar molded less readily.

This seemed to confirm the view that the molds were introduced with and in general grew on the paste, and the [fol. 961] appearance of the mold over a large part of the surface of a cigar indicated the smearing of excess paste over a corresponding portion of the surface.

Remedial Measures

Having located the cause of the trouble in the organisms above discussed and having found the point of their en-

trance, as well as the seat of their activities, to be in the tragacanth paste, practical remedial measures seemed to lie along the line of sterilizing the paste.

In view of the conditions governing the subsequent handling and final utilization of cigars, an acceptable sterilizing agency must combine several characteristics. It must be permanent, since cigars sterilized for but a short time are liable to mold at a later period when conditions of heat and moisture concur with or follow the exposure of the cigars to the infecting organisms. The substance must be odorless and tasteless; otherwise it will alter the taste and aroma of the cigar, points on which smokers, and therefore dealers, are very sensitive. It must not alter the color or the luster of the wrapper, since on these the selling quality of the cigars in considerable part depends.

Sterilization of the Paste

A variety of substances having antiseptic properties were chosen for test. In general they were dissolved in water, and the resulting solutions were either added to the paste already made or were used instead of water in making up the paste. These pastes were then inoculated with the molds obtained from the moldy cigars or from tragacanth gum.

A thin paste containing 10 grams of gum in 1 liter of water was first used. Hydroquinone, thymol and sodium salicylate were introduced in concentrations as strong as could be used without influencing in an objectionable degree [fol. 962] the taste, color, or odor. These pastes were then inoculated with Aspergillus candidus and Penicillium glaucum. In all cultures except that containing 5 c. c. of a molecular solution of hydroquinone in 100 c. c. of paste, both molds appeared and throve.

A thicker paste, containing 10 grams of gum in 250 c. c. of distilled water, was made and a series of cultures prepared to which hydroquinone, thymol, and boric acid were added. Inoculation with the same molds followed. Hydroquinone in permissible concentration failed to suppress the organisms. Thymol in saturated solution, 1 c. c. and 3 c. c. per 100 c. c. of paste, suppressed them, but gave so marked an odor of thymol that the use of this substance was re-

garded as not advisable. Boric acid, 1 c. c. to 10 c. c. of saturated solution in 100 c.c. of paste, failed to suppress the organisms. Indeed, both grew more luxuriantly in these cultures than in the cultures containing simple paste. Cultures containing about 0.12 gram of dry boric acid in 100 c. c. of paste remained sterile.

In a third series of tests, solutions of the disinfectants were used instead of water in making the pastes. Solutions of hydroquinone and of boric acid were used in several proportions, as follows: For 1 gram of dry gum 25 c. c. of solution were used, consisting, respectively, of hydroquinone in molecular, one-half molecular, and one-fourth molecular concentration and boric acid in saturated solution at room temperature and in one-half saturated concentration. Since 60° F. 1 part of boric acid dissolves in 26 parts by weight of water, it will be seen that the stronger boric-acid solution used instead of water in making the paste contained roughly 3.8 per cent of the acid. The paste cultures when made up were decidedly stiff and kept the form of small cakes in the Petri dishes. These cakes were inoculated with the two molds, and the cultures containing hydroquinone [fol. 963] and the more concentrated boric-acid solution remained sterile. The culture containing the one-half normal boric-acid solution proved a more favorable medium for these molds than the plain paste.

It was rendered clear by these experiments that hydroquinone is effective when a solution containing 2.7 grams in 100 c. c. of solution is used instead of water in making the paste. Likewise, when a solution containing roughly 3.8 grams of boric acid in 100 c. c. of solution is similarly used molds are suppressed.

Tests of the adhesive quality of the pastes so prepared were made and it was conclusively shown that the presence of these chemical substances does not decrease the value of the paste in this particular.

After considering which of these substances should be recommended for general use, boric acid was chosen because it is cheaper, does not undergo change in the paste, is more readily obtained, and is not liable to injure anybody if used in excess. The disadvantages of hydroquinone lie in its contrasted properties on the points enumerated.

Practical Directions for Use of the Remedy

A practical course of treatment based on the use of boric acid was accordingly outlined for tests on the factory basis. Since the paste evaporates water between the time of making and of using, a concentration somewhat less than saturation was recommended in making the paste. This would also tend to decrease the liability of the acid to crystallize out in a conspicuous way on the surface of the cigars should paste happen to be smeared on them. The following concise directions were prepared: Place boric acid in warm water at the rate of 1 ounce of dry acid to 1¾ pints of water. Stir till the acid is all dissolved. Use this solution [fol. 964] instead of water in making up the paste. Great care should be taken not to use more paste on the cigar than is necessary, since it is liable to be smeared on the surface of the cigar, where the boric acid in the paste tends to crystallize, giving an appearance suggesting mold.

These directions have been followed for some years in the factory in which the complaints originated, and when the writer was last in communication with those in charge the boric-acid treatment was in use as a routine practice and only in rare instances were molds found troublesome.

Additional copies of this publication may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents per copy.

Washington: Government Printing Office: 1914.

[fol. 965] DEFENDANT'S EXHIBIT No. 12

Annual Report of the Commissioner of Agriculture for the Year 1878

(Stamped:) Library, Jun. 26, 1891, Agriculture.
Washington: Government Printing Office. 1879.

[fol. 966] Borax as a Preservative of Butter

ter of Tuscany and Lombardy that the bad flavor often acquired by butter shipped to foreign countries was derived from the salt used in its preservation. Some impurities ex-

ist in salt, and especially chlorides of lime and magnesia, and they may give a bad flavor to the butter.

But the analysis made of the salt used in Lombardy shows that it is quite as pure as the salt used in Germany or elsewhere, consequently salt alone could not be the principal cause of good butter becoming bad. The antiseptic virtues of borax being well known, as well as the experiments to preserve meat and other edibles by its aid, it occurred that it might be substituted in butter in place of common salt. On trial it was found not to change in the least the flavor of the butter, and indeed preserved it admirably. But some of the farmers of Lombardy did not concur in this opinion. Great care must be taken to have perfectly pure borax, and particularly that it shall not contain any carbonate of soda or alum. It is necessary also to have the borax reduced to a fine powder and thoroughly mixed with the butter in the same proportion as when common salt is used.

The experiments made at the Agrarian Station of Florence, and also at the one of Cassificio, near Lodi, have given good results, after repeated trials. Doubts, however, arose with reference to the physiological action of the borax, as some people thought it a noxious substance. Mr. Cyon reported to the French Academy on the 25th November, 1878, that borax could be added to food in the proportion of 12 grammes daily without being pernicious, and furthermore, by substituting it for marine salt, it would assist its assimilation. On the contrary, Mr. G. Le Bon stated to the French Academy, on the 9th December, 1878, that borax frequently taken, even in very small quantities, was injurious, and ought not to be used even for the preservation of meats, &c. To this Mr. E. Cyon replied, on the 30th December, 1878, insisting upon the innocuous qualities of borax. But Mr. G. Le Bon reiterated his opinion as to the bad consequences of using it for the above purpose. With this difference of scientific opinion, great circumspection was neeessary in adopting the use of a substance which might be very pernicious to health, even if taken in very small doses. At this juncture, Prof. Emilio Bechi, director of the Agrarian Station in Florence, made an important discovery, which throws some light on the question. For a long time Professor Bechi had been occupied in studying the borax mines in Tuscany, and has discovered and analyzed

some new borax minerals, one of which Professor Dana, of New Haven, called in his honor Bechilite. Several reports on the borax deposits have been presented recently to the Academy of the "Lincei," at Rome, by its president, Quintino Sella. One by Professor Bechi was read at the academy on the 4th instant, stating the presence of borax in very many of the rocks and in the mineral water of Monteeatoni; also in the wells of Florence, in the ashes of plants, and in the air itself. From this fact Professor Bechi argues that neither borax nor boracic acid, in very small quantities, however often taken, would do injury, and that it may be used for the preservation of butter or meats with entire safety.

For his family use Professor Bechi preserves his own butter in the following way: By heat he evaporates the water of crystallization; then he reduces the borax to finest powder, and adds to the butter in the proportions of 6 parts of the former to 100 of the latter, thoroughly and equally intermixed. It is then put into the same sort of jars as are used for salted butter. His method is simply substituting borax for salt. For daily family use he finds that butter keeps fresh in water with only 3 per cent. of borax. Still he admits, although his own ex-

---

[fol. 967] TRANSLATION OF DEFENDANT'S EXHIBIT No. 13

Journal d'Agriculture Pratique, 1883, Jan. 19, Vol. 46/I, pp. 75-76

The greater part of the treatment trials made
(P. 75.) at Nerac depended on the use of poisonous and antiseptic substances in solution in water which were sprinkled on the leaves in a state of mist by means of a spray-nozzle. The distribution of the active matter was thus carried out by this method in the most regular and perfect manner. Of all the substances thus
(P. 76.) applied, that which gave us the most satisfying results is borate of soda (borax) which we employed in the proportion of five grams per liter of water. In these experiments, made on a small scale, it is true, and at the end of the season, this solution deposited in fine

droplets over the leaf appeared to not only destroy the rotten spots formed by the mold without changing the leaf, but also to impede the growth of the parasite. On comparing a treated leaf several days after the operation with a non-treated leaf, both having been kept in a very moist medium, the difference was most striking; one appeared to be completely free from the parasite, whereas the other was completely overrun.

Nevertheless I verily do not believe the treatment to be capable of preventing the reappearance of new rotten spots. On account of the premature interruption due to the frost our tests have as yet not been such as to reveal the measure of efficaciousness of the new remedy; repeated tests are indispensable to establish its value. Moreover I think that like all the other treatments such as those with flowers of sulfur, lime, the spraying with borax—provided its useful effects have been ascertained—will be the more efficacious the sooner its application has been resorted to [fol. 968] after the incipient stages of the spreading of the disease, considering that it is particularly upon the multiplication of the parasite, upon its propagation upon the first leaves attacked upon the still intact new shoots that one can hope to act efficaciously.

[fol. 969] DEFENDANT'S EXHIBIT No. 14

Proceedings of the Indiana Academy of Science, Twenty-fifth Anniversary, 1909

Editor: H. L. Bruner

Indianapolis, Ind. 1910

391

[fol. 970] The Effect of Preservatives on the Development of Penicillium

By Katherine Golden Bitting

In examining ketchup for the organisms present, it was noted that the hyphæ of moulds in preserved ketchup were swollen and distorted. In many of the brands of ketchup,

the mould present was the common blue mould. Penicillium. As this mould is apparently omnivorous in habit, thriving and fruiting on many media, has been used in many physiological investigations to determine the nutritive value of many compounds, grows normally in liquid media, and fruits normally in a saturated atmosphere, is regular in its germinative power, and, so far as known, constant in form, it was selected to determine the effect of sodium benzoate, used in varying quantities, on its structure and development. The media used in the experiments were tomato bouillon, tomato gelatin, and tomato pulp, and were selected because the tomato juice and pulp are present in ketchup, and also because they do not alter the toxic properties of the agents used toward the fungus. Afterwards the condiments used in ketchup were tested and also the ordinary food preservatives, though not so extensively as the sodium benzoate. In these latter experiments tomato bouillon was the only medium used.

The bouillon was made by adding to a can of tomatoes an equal volume of water, boiling for about half an hour, and then filtering. The filtrate is clear, and a good medium for growth. It has an acidity of approximately .2% calculated as citric acid. For the tomato gelatin, 10% of gelatin was added to the tomato bouillon, cleared with egg, and filtered. The tomato pulp was obtained from a factory, and was made from whole tomatoes. To these media the sodium benzoate was added in the various amounts used in factory practice. Before sterilizing the media, calendared paper was tied closely over the cotton plug to prevent the distillation of the benzoate. After sterilization and cooling, the media were inoculated with spores from a vigorously growing culture of the mould. During development, the cultures were kept at room temperature, unless otherwise stated. The method of culture was by moist chambers and flasks for the bouillon and gelatin, and Petri dishes for the pulp. The moist

400

[fol. 971] The tables show the germinative power and also the gross effect in development. The moist chamber cultures gave closer results on the germination and the earlier effects on growth, but were not as satisfactory as

the flask cultures in showing the general effect on development. In the flasks the amount of development, the method of formation, and the color in maturing could be seen to better advantage.

The 5% salt had a retarding effect, and also induced an abnormal development, the growth being confined to a small amount of curled surface mycelium not spreading normally over the surface, and some submerged colonies. The sugar caused a delayed, stunted development, sometimes the growth in the 50% consisting of a scanty, submerged mycelium. In lesser amounts than 25% a thin surface mycelium forms, with a thick layer of spores. The cinnamon and cloves in the 5% solutions were stimulating, while stronger solutions retarded the development, the cloves being stronger in action than the cinnamon. In the 5% solution of alcohol in the moist chambers the conidia became swollen as they do previous to germination, but no further development took place. In the flask cultures the action of the alcohol was weaker, the conidia germinating and forming small colonies, which was probably due to the evaporation of the alcohol, causing the solution to become weaker on standing. The ½% acetic acid retarded growth, and caused the mycelium to wrinkle. In all the flask cultures with the exception of the alcohol the effect of the condiment of corresponding per cent. was stronger than in the moist chambers.

Preservatives

The preservatives are those which have been used in foods, and used in approximately the same amounts. The results show that they have a retarding effect on the development of the mould, even when in small amounts, and that most of them become inhibitive when the amounts are increased, the increase not exceeding the amounts which have been used in foods.

[fol. 972] Effect of Preservatives on Development of Pernicillium

Moist Chamber Cultures, 80° F.

Solutions	21 hours. Germination	21 hours. Hyphæ length in μ	28 hours, Hyphæ length in μ	48 hours, Hyphæ length in μ	Description
Tomato bouillon	100%	307.6	999.7	∝	Conidiophores formed.
Tomato bouillon + sodium benzoate, 1-10%	100%	46.1	169.2	∝	Conidiophores formed.
" " " " 1- 5%	——	——	30.8	∝	Conidiophores starting. Only about 50% spores have developed.
" " " " 1- 2%	——	——	——	——	
Tomato bouillon + benzoic acid, 1-10%	25%	30.8	46.1	∝	Only about 35% spores have developed.
" " " " 1- 5%	——	——	15.4	769.0	" " 50% " " "
" " " " 1- 2%	——	——	——	——	
Tomato bouillon + borax, 1-10%	100%	276.8	461.4	∝	Conidiophores formed.
" " " 1- 5%	100%	15.4	30.8	..	No change after 28 hours.
" " " 1- 2%	——	——	——	——	
Tomato bouillon + boric acid, 1-10%	50%	76.9	307.6	492.2	
" " " " 1- 5%	50%	15.4	30.8	.....	No change in hyphæ after 28 hours. 50% spores swollen.
" " " " 1- 2%	——	——	——	——	About 10% of the spores swollen.
Tomato bouillon + sod. salicylate, 1-10%	100%	46.1	307.6	∝	Conidiophores formed but have few sterigmata.
" " " " 1- 5%	100%	123.0	169.2	∝	Thin mycelium, conidiophores formed close to germinated spore.
" " " " 1- 2%	10%	15.4	76.9	∝	
Tomato bouillon + salicylic acid, 1-10%	50%	30.8	123.0	∝	Like the 1-5% sod. salicylate.
" " " " 1- 5%	——	——	——	——	
" " " " 1- 2%	——	——	——	——	

[fol. 973]

Effect of Preservatives on Development of Penicillium.

Flask Cultures, 50 cc. Medium; 80°.

Solutions	24 Hours	48 Hours	72 Hours	18 Days	
Tomato bouillon	Tiny colonies at edge	Edge colonies 3/8"	Ring 1/2", center blue, many sub. col.	Surface covered, wrinkled, olive. Liquid nearly black.	1
Tomato bouillon + sod. benzoate, 1-10%	.....	Tiny colonies at edge, few submerged	Slight increase	Surface covered, wrinkled, olive. Liquid darkened.	2
" " " " 1- 5%	.....	.....	.....	Surface nearly covered, green, mycelium still growing.	8
" " " " 1- 2%	.....	.....	.....	.....	.....
Tomato bouillon + benzoic acid, 1-10%	.....	.....	.....	Surface nearly covered, wrinkled, green, mycelium growing.	6
" " " " 1- 5%	.....	.....	.....	.....	.....
" " " " 1- 2%	.....	.....	.....	.....	.....
Tomato bouillon + borax, 1-10%	Tiny colonies at edge	Edge colonies 1/4", many submerged	Ring 3/8"	Surface covered, wrinkled drab, thin spore layer. Liq. dark.	1
" " " 1- 5%	.....	.....	Few tiny submerged colonies	Few surface col., curled, drab, thin spore layer, many sub.	3
" " " 1- 2%	.....	.....	.....	.....	.....
Tomato bouillon + boric acid, 1-10%	Tiny colonies at edge	Edge colonies 1/4", many submerged	Few surface colonies curled	Surface partly covered, curled, thin spore layer, many sub.	1

Effect of Preservatives on Development of Penicillium—Continued.

Flask Cultures, 50 cc. Medium; 80°—Contniued.

Solutions	24 Hours	48 Hours	72 Hours	18 Days	
Tomato bouillon + boric acid, 1- 5%			Few submerged colonies	Same general appearance as 28, but less developed.	3
" " " " 1- 2%				Tiny submerged colonies.	14
Tomato bouillon + sod. salicylate, 1-10%			Few colonies at edge	Surface nearly covered, wrinkled, olive, liquid darkened.	3

* No. days to germinate

[fol. 974] Microscopic Appearance of Penicillium—Continued

Preservative	Size of germinated conidia in μ	Characteristics of development
Sodium formate, 1.5%	13.3	Hyphæ swollen, coarsely granular protoplasm; short side branches, blunt ends, disorganized, or normal size with fine granules and many vacuoles, some cells empty.
Sodium formate, 1-2%	13.6	Hyphæ swollen, coarsely granular, short side branches which do not develop, blunt ends, disorganized, break easily.
Formic acid, 1-5%	14.0	Hyphæe swollen, coarsely granular, blunt ends, many broken or normal size, finely granular, many vacuoles.
Formic acid, 1-2%	11.4 41.8	Hyphæ swollen, coarsely granular, yellow, distorted, badly disorganized, break easily. Nearly all germinated conidia broken.

The sugar and salt caused the hyphæ to shrink and to assume distorted shapes when in sufficient amounts to cause a retardation. The cranberry juice, both raw and cooked, also caused shrinkage, and the raw juice a distortion. All of the others caused the conidia and hyphæ to swell and some of them also caused a distortion. The mould grown in the alcohol solution had tough walls in spite of the swelling, and a clear, sharp appearance. The borax and boric acid also produced a clear appearance. The sodium benzoate, benzoic acid, sodium salicylate, salicylic acid sodium formate, formic acid, acetic acid, and cinnamon produced swelling distortion, a disorganization of both the protoplasm and cell wall, and a yellowing of the protoplasm. The cell wall had no elasticity nor toughness, so that the placing of the cover-glass gently on a mount was sufficient to break the walls of the more distended hyphæ and to allow the protoplasm to flow out. The protoplasm appeared to be without coherence; when the wall gave way it flowed in all directions, as if it were composed of loose particles having no cohesion. The sodium sulphite, saccharin, cloves, and copper sulphate growths had similar characteristics to those enumerated for the other preservatives, but not so strongly developed.

In summarizing the results, there seem to be two different actions induced by the action of the substances on the protoplasm, in one case a plasmolyzing effect causing a

shrinkage and distortion, as in the salt and sugar, and in the other case a toxic effect producing a disorganization of both the protoplasm and wall, and a discoloration of the protoplasm, the substances showing varying degrees of toxic power.

[fol. 975] Germination from Preservative Material

To determine if there were a permanent deleterious effect produced on the plant through the toxic effect of the chemicals, inoculations were made from two weeks' old cultures into tomato bouillon. The result is shown in the table:

Ger-mination of Penicillium Grown in Preservative Solutions 14 Days

---

Germination of Penicillium Grown in Preservative Solutions 14 Days

Preservative	Number days to germinate	Stage of devolopment in 5 days
Control	1	Surface covered, green.
Sodium benz. 1-10%	2	Surface covered, green.
" " 1- 5%	2	" " "
" " 1- 2%	4	Thin ring, having blue dots.
Benzoic acid, 1-10%	2	Surface nearly covered, green.
" " 1- 5%	4	Small surface colonies, blue.
" " 1- 2%	..	.....
Borax, 1-10%	2	Surface covered, green.
" 1- 5%	2	One surface colony, green.
" 1- 2%	..	.....
Boric acid, 1-10%	1	Surface covered, green.
" " 1- 5%	2	" nearly covered, green in center.
" " 1- 2%	5	Few submerged colonies.
Sod. salicylate, 1-10%	1	Surface covered, green.
" " 1- 5%	2	" " "
" " 1- 2%	1	" " "
Salicylic acid, 1-10%	1	" " "
" " 1- 5%	1	" " "
" " 1- 2%	..	.....
Sod. sulphite, 1-10%	3	Colonies on surface, green.
" " 1- 5%	2	Surface covered, "
" " 1- 2%	..	.....
Saccharin, 1-10%	2	Surface covered, green.
" 1- 5%	2	" " "
" 1- 2%	1	" " "
Copper sulphate, 1-10%	3	Colonies on surface, green.
" " 1- 5%	2	Surface covered, "
" " 1- 2%	2	" " "

[fol. 976] The germination and subsequent development indicate that the preservative affected the conidia deleteriously, as some were retarded, while the conidia from the solutions showing the strongest effects on the previous development, did not germinate, except from the ½% boric acid solution which formed a few submerged colonies, no surface development taking place. Lafar[1] states that the

Summary

Salt and sugar injure the plant by preventing normal action of the protoplasm through plasmolysis.

Alcohol hardens the protoplasm and walls and prevents development.

Cranberry juice, both raw and cooked, retards development and causes shrinkage, though not having the appearance of the shrinkage due to plasmolysis.

All of the other chemicals tested acted as poisons on the protoplasm, retarding development and causing abnormal swelling and disorganization of varying degrees of intensity on both the protoplasm and cell membrane.

Lafayette, Ind.

Explanation of Photographs

The photographs have the same magnification, ×395, so that comparisons may be made as to the effect of the preservatives. The specimens were submerged colonies in all cases except the raw cranberry and cinnamon, and no submerged colonies developed in these solutions. The endeavor was to have all of the same age, but this was impossible, as some developed much more rapidly than others, and in those which were slow in developing it was impossible to determine the changes which the conidia may have been undergoing before the development had attained the

[1] Lafar, F., Technical Mycology, Vol. II, Part 1, p. 40.

waterproof character of the conidial walls has a value in preventing the entrance of poisons to the protoplasm, but in the cases noted it is either dissolved by the chemicals or powerless to prevent their pasasge, for the results indicate that they exercised a decided toxic effect on the protoplasm.

colony stage. The submerged colonies were used as soon as they made their appearance. In some of the specimens that show little or no swelling the disorganization can be seen in the collapsed ends of the hyphæ and the floating fragments of protoplasm.

[fol. 977] TRANSLATION OF DEFENDANT'S EXHIBIT No. 15

[Verslagen Kon. Akad, v. Wetenschappen, Amsterdam, pages 342-345]

Page 342

(From the Institute for Organic Chemistry of the Technische Hochschule at Delft. Director: Prof. Dr. J. Boeseken)

On the Effort of Boric Acid and Several Other Compounds Upon the Development of Penicillium Glaucum and Aspergillus Niger

By J. Boeseken and H. I. Waterman

In several previous communications[1] we have shown that the inhibiting effect of numerous organic compounds upon the development of Penicillium glaucum runs parallel with their solubility in fat, insofar as they are also somewhat soluble in water.

We have therefore expressed the conjecture that all substances have to pass a stratum of water before they get to the protoplasm wall. There they are then conveyed further, and if it is assumed that the protoplasm is bounded by a stratum in which lecithins preponderate, then it is very conceivable that compounds which are somewhat soluble in water and highly soluble in olive oil can penetrate rapidly into the interior of the organism and overload it. Secondly we have shown that this explanation is no longer [fol. 978] admissible when we are dealing with the injurious effect of strong organic acids.

---

[1] Boeseken and Waterman, Verslagen Kon. Akad v. Wetenschappen, Amsterdam, Nov. 25, 1911, Jan. 27, 1912, March 30, 1912.

Oxalic acid and tartaric acid are substances which are insoluble in fat and which nevertheless have a very strong inhibiting effect upon the development of the fungus at certain concentrations.

Page 343: We have found that this effect is exerted by the hydrogen ions. It follows therefrom, however, that these acids—and this holds true also for sulfuric acid—are, in spite of their insolubility in fat, able to penetrate the protoplasm wall, and that the latter cannot possibly consist of a closed stratum of oil. We have therefore assumed that it is an aqueous colloidal solution of lecithins, etc., mixed with albuminous constituents.

The toxic effect of the hydrogen ions we have then attributed to deflocculation of these colloids.

In the case of the hydrogen ions this deflocculation may be imagined as caused by a neutralization of the negatively charged plasma colloids, i. e. by a physical process, as it were, and because all acids behave identically, we have also accepted this explanation.

In the case of boric acid, however, the circumstances are different; it is sufficiently soluble in water, but its dissociation constant is extremely small.

Boric acid is practically insoluble in olive oil—a fact of which we have convinced ourselves by an experiment—and yet its inhibiting effect upon the development of Penicillium glaucum is in several cases surprisingly great. Hans Meyer[1] includes boric acid in the compounds that are soluble in lipoids, and sees therein the cause of its action.[2] Boric acid would accordingly belong to those compounds which are [fol. 979] not soluble in olive oil but which have a large lipoid-water partition quotient. We are more inclined to attribute the effect of boric acid to its binding capacity. We are here thinking primarily not only of the lipoids of the cell,[3] but of the albuminous substances and other materials of the boundary stratum of the protoplasm.[4] The

---

[1] 7th International Congress of Applied Chemistry, June, 1909 (Physiological Chemistry and Pharmacology).

[2] Cf. also Hober, Physik. Chemie der Zelle u. der Gewebe, 3d edition, Leipzig, 1911, page 395.

[3] Hans Meyer, loc. cit.

[4] Cf. Pfeffer, Planzenphysiologie. Volume 2, Kraftwechsel, 1904, page 342.

reactivity of boric acid, as well as that of other inorganic substances, for organic complexes has been known for a long time; its is only necessary to think of Magnanini's researches on the organo-boric-acid compounds, for example on mannito-boric acid.[1]

Page 344. Numerous compounds which contain the hydroxyl group have recently been examined as to their behavior toward boric acid.[2] If these researches are not devoid of interest for organic chemistry and particularly for determination of constitution, they were significant also for our case. It is just among the foodstuffs that the compounds which contain the hydroxyl group occupy a prominent position. Now the question was how the constitution of the foodstuff would affect the inhibiting effect of boric acid. For we were investigating the effect of boric acid upon the development of Penicillium glaucum in various media. The only sources of carbon used successively were: cane sugar, mannite, glucose, mannose, levulose, rhamnose,[3] maltose, lactose, arabinose, xylose, glycerin, galactose, rhamninose,[3] raffinose, sorbite, dulcite, paraoxybenzoic acid, protocatechuic acid, and ballic acid. The result of these experiments was the following: the greater the binding capacity of the boric acid for the source of carbon in question, [fol. 980] the smaller was its inhibiting effect. As a matter of fact this result was probably to be expected; the more firmly the boric acid is held in the nutrient solution, the more difficulty will it bring its effect to bear upon the organism in sufficient quantity, or, in other words; the antiseptic effect is dependent upon the medium. As a matter of principal this does not afford us anything new, only we have to deal in this case with definite compounds, and on the other hand the conclusion may be drawn from our experiments that an organic compound has a tendency to combine with the boric acid. Thus we found, for example, that levulose impairs the inhibiting effect of the boric acid

---

[1]Gaz. Chim. it. 1890, I, pages 428-441, and II, page 215; 1891, II, pages 134-141.

[2]Boeseken and v. Rossem, Rec. d. trav. chim. d. Pays Bas et de la Belgique, vol. XXX, page 392.

[3]We owe these preparations to the kindness of Professor H. ter Meulen, for which we here express to him our hearty thanks.

more decidedly than glucose. As a matter of fact it was possible to determine, by means of conductivity measurements that levulose exerts a greater influence upon boric acid than glucose. In all of our experiments a definite quantity of the source of carbon (Table I) was dissolved in 50 cu. cm. of tap water which, in addition to the inorganic constituents always present in it, contained also 0.05 per cent of NH_4Cl, 0.05 per cent of KH_2PO_4, and 0.02 per cent of $MgSO_4$. Inoculation was carefully performed with a pure culture of Penicillium glaucum. The temperature was 21° [70° F.].

Page 345:

[fol. 981] [Verslagen Kon. Akad. d. Wetenschapen, Amsterdam, pages 349 and 351]

Striking in character is the slight inhibiting effect of boric acid in the case of mannite, levulose, sorbite, dulcite, as well as in the case of protocatechuic acid and in the case of gallic acid, compared with a concentration, even though a lesser concentration of paraoxybenzoic acid. By means of these experiments we have accordingly ascertained that the chemical combination exerts a negative influence in connection with the action of boric acid. It is now obvious to assume that, as already stated above, in the real action itself the chemical linkage will play an important part. Some day it will perhaps be possible to detect such a direct chemical compound between boric acid or other inorganic compounds and one or several constituents of the protoplasm. Just if one takes a chemical linkage as the basis of the effect of boric acid is it easily conceivable why the inhibiting effect will be such a specific one. Thus Aspergillus niger (Table II) is far more resistant with respect to boric acid than Penicillium glaucum. The same thing is true also for numerous enzymes: of. Bertrand,[1] Agulhon,[2] Rosenblatt and Rozenband.[3]

Although the experiments with Penicillium glaucum and with Aspergillus niger are not directly comparable, because the temperature was not the same, we can never-

[1]Comptes rendus, 145 (1907), page 340. Annales de l'Inst. Pasteur, XXI (1907), page 673.

[2]C. r., 148 (1909).

[3]C. r., 149 (1909), page 309.

theless draw the conclusion that Aspergillus is far more resistant with respect to boric acid than Penicillium glaucum (cf. also our experiments on the action of the hydrogen ions).[1]

[fol. 982] Whereas in the latter case as little as 0.06 per cent exerts a distinctly deleterious influence, this figure lies much higher in the case of Aspergillus, namely only at 0.5 to 1 per cent of boric acid.

In addition to boric acid several other inorganic compounds were also investigated. Now, a good comparison between the various metallic salts is very dif-

Page 351: ficult. Some of them are reduced by the organic substances that are present (in our case the paraoxybenzoic acid), others are oxidized even by the air, and finally several of them are hydrolytically dissociated in their solutions, so that in the last case a large quantity of hydrogen ions may be present in the solution. Then, too, the formation of precipitates cannot be obviated, etc. It was accordingly to be expected that a series of qualitative experiments with metal-salt solutions cited. As a matter of fact the solubility of corrosive sublimate in olive oil is very considerable. This we have further been able to confirm by means of an experiment. (Per 100 grams of oil > 600 miligrams of corrosive sublimate). This is, however, not the case with cadmium chloride, for this compound is only slightly soluble in olive oil. It is accordingly more probable that the cause of the toxic effect of this and many other metal salts, like that of boric acid, is not a purely physical one, but also and primarily a chemical one; these are exactly the elements which are most capable of forming complex compounds.

Page 358: That in the inhibiting effect which several inorganic compounds exert upon the development of Penicillium glaucum their chemical combining power will be determinative, we accordingly regard as very probable. Recently, in particular, investigations have again been carried out in this direction[2] which render

---

[1] Boeseken and Waterman, Verslagen Kon. Akad. v. Wetensch. Amsterdam, March 30, 1912.

[2]a. Weinland and Binder, Ber. der deutschen Chem. Ges. 45 (1912), pages 148, 1113.

b. Also in the laboratory.

[fol. 983] probable, for example, a compound from ferric hydroxide and substances such as pyrocatechin and pyrogallol.

Summary

A. We ascertained: I. That boric acid, even in extremely low concentration (+0.06 per cent), has a distinctly inhibiting effect upon the development of Penicillium glaucum, and that this deleterious concentration is much higher in the case of Aspergillus (0.5 to 1 per cent).

II. That this effect of boric acid depends, however, upon the organic substances which are present in the nutrient solution. The stronger their combining power, the weaker is the effect of the boric acid.

B. The conjecture was expressed that the actual deleterious effect of boric acid and of many other inorganic compounds must also be attributed to selective chemical combination.

[fol. 984] DEFENDANT'S EXHIBIT No. 16

Insecticides, Fungicides, and Weedkillers

A Practical Manual on the Diseases of Plants and Their Remedies, for the Use of Manufacturing Chemists, Agriculturists, Arboriculturists, and Horticulturists,

By E. Boucart, D. Sc.

Translated from the French, Revised and Adapted to British Standards and Practice by Donald Grant, with Eighty-three Tables and Twelve Illustrations

(Perforated:) Library, U. S. Department of Agriculture

London: Scott, Greenwood & Son, 8 Broadway, Ludgate, E. C. 1913

[The sole rights of translation into English remain with Scott, Greenwood & Son.]

D. Van Nostrand Company, New York:

[fol. 985] than white arsenic and consequently much more poisonous to plants. In the composition of arsenical

bouillies its formation must be guarded against, or its effects neutralized by the addition of lime.

Use.—The soluble arsenites, such as the salts of potassium, ammonium, as well as the soda salt, have been serviceable owing to their great solubility and their immediate action on insects and injurious animals. But this use is, perforce, limited, and then can only be used to poison preparations to be eaten by insects and rodents.

Disinfection of Seed-Corn.—Boussingault proposed in 1856 to replace arsenic by arsenite of soda. He recommended to water gradually with constant stirring 2¾ bushels of grain with a solution of 200 grammes of arsenic and 600 grammes of soda crystals in a few litres of water. In an hour the grain was spread out to dry. This method was abandoned long ago.

Preparations to Kill Locusts.—In the British Colonies they prevent the migration of locusts by placing in their way bunches of fodder, herbs or maize stems, steeped in a solution containing per hectolitre 60 grammes of arsenious acid, 60 grammes of caustic soda, and 10 kilogrammes of white sugar or molasses [or 60 oz. (wt.) of arsenious acid, 60 oz. of caustic soda by weight, and 1000 oz. of sugar (wt.) in 100,000 fluid ounces of water]. Drying is prevented by covering the bait with a board or a stone. This bait may be used for other insects.

28. Borax, $Na_2B_4O_7$.—Occurrence.—Borax occurs naturally in the lakes of Asia, from which it is extracted by evaporation and crystallization.

Preparation.—By gradually adding 100 lb. of Tuscan boric acid to 125 lb. of soda crystals dissolved in 20 gallons of water and then heating by steam. The mixture is concentrated at 30° B., and cooled slowly; crystals of borax form at the bottom of the receiver. The double borate of soda and lime or boronatrocalcite is widely distributed in America; it is now used to manufacture a large amount of borax obtained by boiling this product with carbonate of soda.

Properties.—Borax is freely soluble in water. A hundred lb. of borax dissolve in 120 gallons of cold water and the same amount in 20 gallons of boiling water. Its solutions react alkaline. Borax is used in medicine as an antiseptic, especially in throat and mucous affections. It is

used to preserve meat and putrescible liquors. Werncke found it more active from that point of view than boric acid. Its antiseptic and bactericidal capacity is, however, very weak. Kuhn found that it only acted in 2 per cent solution. Schwartz, however found that the bacteria of the infusion of tobacco were exceptional, and that a 0.5 per cent solution had already a certain effect on these microbes. Wenckiewicz found that it had no action on Penicillium glaucum until its solution reached 1.4 per cent. Borax exerts a poisonous action on plants. By watering haricots with a very dilute solution of borax Peligot first induced chlorosis, then death.

Use.—Borax has been recommended in 5 per cent solution in America against the Peronospora viticola De By. (mildew of the vine). At that strength it can circumscribe that disease, but its use is not without drawback, for it [fol. 986] burns the leaves of the vines treated. Care should be taken to wash these a few hours after treatment. Muhlberg found borax solutions did not kill the Schizoneura lanigera, Hausn., against which it had been recommended.

29. Carbonate of Soda, Na_2CO_3.—Preparation.—By the Solvay (Brunner, Mond) process principally. A concentrated solution of common salt is first saturated with ammonia, then a prolonged current of carbonic acid is passed through; bicarbonate of ammonia is produced, which acts on the common salt to convert it into carbonate of soda. The precipitate is filtered, drained, and calcined.

Properties.—Carbonate of soda crystallizes in prisms; the crystals lose their water of crystallization at the ordinary temperature. Heated, they melt in their water of crystallization, dry, and form calcined carbonate of soda (soda ash), which is an amorphous white powder containing no water. Soda crystals are much more soluble in hot water than in cold: the maximum solubility is at 38° C.; one gallon of water dissolves 6.04 lb. at 14° C., 166.6 lb. at 38° C., and 44.5 lb. at 104° C. Carbonate of soda in solution has a strong alkaline reaction.

Action of Carbonate of Soda on Plants.—Around alkali works the presence of this salt, carried by the wind does much damage. Eventually the carbonate of soda, covering the leaves with a white layer, more or less thick, causes

them to drop off, and kills the trees themselves. Rye suffers much from contact therewith; the ears are almost empty, and the few grains which they contain are shrivelled and blackish. When plants have been in contact with carbonate of soda the analysis of the ash reveals a quantity of soda superior to the normal quantity. The straw of cereals is more brittle, and contains less silica. Carbonate of soda acts like carbonate of potash; when it is a case of neutralizing the acidity of certain marshy lands carbonate of soda may play the part of lime, and the nitric ferments, which cannot act except in slight alkaline media, may thereby modify the flora of the field. In such conditions carbonate of soda, in small dose, may exert a favourable influence on vegetation.

Action on Fungi.—Wuthrich treated the spores of different fungi with sodium carbonate with the following results: A solution of 0.053 per cent prevents the conidia of the Phytophthora infestants, De By., from producing zoospores, but it does not injure their direct germination; life is only arrested by immersing the conidia in a 0.53 per cent solution. As to the conidia of the Peronospora viticola, De By., Wuthrich found sodium carbonate more energetic; a 0.053 per cent solution hindered the growth of the spores, and a solution of 0.53 per cent stopped it entirely. The uredospores of Puccinia graminis, Pers., show, more than any other spores, a great resistance to carbonate of soda solutions, but germination is hindered by 0.53 per cent solution and stopped entirely by immersion in a 2.65 per cent solution.

Action on Insects.—All soft-skinned insects are sensitive to strongly alkaline substances, but these subtances in themselves are not very powerful insecticides; they are, therefore, combined with toxic substances.

Use.—Carbonate of soda enters into the composition of certain

[fol. 987] DEFENDANT'S EXHIBIT No. 17

The Effect of Certain Agents on the Development of Some Moulds

By K. G. Bitting, M. S., Bacteriologist Glass Container Association of America

[fol. 988] The Physiological Effect of Various Agents on the Development of Penicillium Expansion, Alternaria Solani, and Oidium Lactis

Introduction

It is well known that many chemicals, drugs and ordinary household substances possess preservative properties to a greater or less degree, depending to some extent upon how they are used. In order to determine the physiological effect of some of these agents upon living matter, a series of experiments was made, using three moulds, which are well known, Penicillium expansum Link, Alternaria solani (E. & M.) Jones and Grout, and Oidium lactis Fresenius. In much of the work of this nature, the tests have been made on either the low organisms, the bacteria, or the higher forms of plants and animals, the results being necessarily confined to the bare facts of retardation or inhibition of development for the former, as they are too minute to note structural changes other than those of form, and for the latter are confined to diagnostic features, as examination of the effect on the tissues is precluded during life. In the present work the nature of the organisms selected permits of minute changes in structure being seen during life as well as the more obvious changes in kind and degree of development. In the preliminary work, a yeast was used in conjunction with the moulds, but the yeast development could not be determined in turbid solutions nor on some solid media, nor could slight changes in the microscopic structure be recorded readily by means of photomicrographs, which were used throughout the work for permanent records and for comparison. As the elimination of this feature of the work precluded close interpretation of the results, the work on the yeast was discontinued.

The records for the experiments are given as to the effect of the different agents used in varying degrees of concentration, usually to the highest point at which growth occurred. Following is a brief description of the moulds grown under conditions which permit normal development.

Penicillium expansum Link.—The Penicillium in developing forms a white, felt-like mass, covering the medium on which it is growing. As development proceeds, the mould changes to bluish green, due to conidial development, then to olive green, finally to a darker duller color. Thom[1] states that, "The shades of color peculiar to each species under oft repeated conditions are easily recognized and are quite reliable."

Alternaria solani (E. and M.) Jones and Grout.—Alternaria forms a white abundant growth at first, which darkens later, due to the darkening of the hyphal walls and the formation of the brown conidio. During the early stages of development the mycelium becomes of a greyish color, due to the darkening of the reverse side of the mycelium, but later the whole growth becomes very dark and under some conditions wholly black.

[1] Cultural Studies of Species of Penicillium. Bull. 188, B. A. I., Dept. of Agr. 16, 1910. 1910.

Development Features—Continued.

Agents: Kind	Agents: Per cent	No. days to germinate	2 days	3 days	4 days	5 days
Salicylic acid	0.2	4	.....	.....	Few tiny surface and submerged colonies.	Slight increase.
Sodium salicylate	0.5	5	.....	.....	.....	Two tiny curled colonies.
Alternaria:						
Alcohol	5.0	2	Many tiny submerged colonies.	.....	.....	Colonies larger.
Benzoic acid	0.01	2	Few tiny submerged colonies.	.....	.....	Slight increase.
Sodius benzoate	0.01	2	Few tiny submerged colonies.	.....	.....	Slight increase.
Boric acid	0.5	4	.....	.....	Many submerged colonies.	
Borax	0.5	5	.....	.....	.....	Submerged colony.
Creosote	0.01	1	Tiny submerged colonies	.....	.....	Slightly less than control.
Creosote	0.02	6	.....	.....	.....	.....
Formaldehyde	0.02	1	One tiny submerged colony.	.....	.....	Few small submerged colonies.
Formic acid	0.5	7	.....	.....	.....	.....
Sodium formate	0.5	3	.....	Submerged colony...	.....	Slight increase.
Saccharin	0.2	3	.....	Many submerged colonies.	.....	Increase in size.
Salicylic acid	0.02	2	Few small submerged colonies.	.....	.....	Slightly increased.
Sodium salicylate	0.05	5	.....	.....	.....	Tiny submerged colony.

Development Features—Continued

Agents		No. days to germinate	2 days	3 days	4 days	5 days
Kind	Per cent					
Oidium:						
Alcohol	5.0	2	Many surface and submerged colonies.	Surface covered.		
Benzoic acid	0.02	5	.....	.....	.....	Many surface and submerged colonies.
Sodium benzoate	0.03	3	.....	Many small submerged colonies.	.....	Surface covered white, thick.
Boric acid	0.2	3	.....	Many small submerged colonies.	.....	Few surface colonies.
Borax	0.5	7	.....	.....	.....	.....
Creosote	0.05	3	.....	One tiny submerged colony.	.....	Many small submerged colonies.
Formaldehyde	0.1	4	.....	.....	Few submerged colonies.	Slight increase.
Formic acid	0.2	7	.....	.....	.....	.....
Sodium formate	0.5	3	.....	Many submerged colonies.	Thin film	Thick, white.
Saccharin	0.3	2	Many submerged colonies.	.....	Surface covered.	
Salicylic acid	0.05	3	.....	Few submerged colonies.	.....	Increased.
Sodium salicylate	0.05	1	Thin film, many submerged colonies.	Thick white.		

Agents: Kind	Agents: Per cent	Size of germ. conidia in μ	Characteristics of development
Penicillium:			
Alcohol	5.0	15.2	Hyphae swollen, distorted, walls tough; protoplasm clear.
Benzoic acid.....	0.1	49.4	Hyphae larger than in benzoate, more easily broken, distorted.
Sodium benzoate..	0.2	15.2 38.0	Hyphae and conidia swollen and distorted, no uniformity in formation of septa, some hyphae have few, others many; protoplasm coarsely granular, filling tubes; walls break readily.
Boric acid.....	0.2	15.2 19.0	Hyphae swollen, short thick side branches, blunt ends, protoplasm finely or coarsely granular.
Creosote	0.04	9.5	Hyphae nearly as wide as germinated spore, many septa; protoplasm homogeneous, many fine vacuoles, many short side branches develop into fruiting heads, having few branches.
Formaldehyde	0.1	7.6	Hyphae attenuated, septa distinct; protoplasm appears solid, shrunken from walls. Fruiting heads have stringy branches, conidia have refractive greenish content, shrunken.
Formic acid	0.2	14.0	Hyphae swollen, coarsely granular, blunt tips, many broken, or, normal size, finely granular, many vacuoles.
Formic acid	0.5	11.4 41.8	Hyphae swollen, coarsely granular, yellow, distorted, badly disorganized, break easily. Nearly all germinated conidia broken.
Sodium formate ..	0.2	13.3	Hyphae swollen, short side branches, blunt tips, protoplasm coarsely granular, disorganized; or, hyphae normal size, protoplasm finely granular, some cells empty.
Sodium formate...	0.5	13.6	Hyphae swollen, short undeveloped side branches, blunt tips; protoplasm coarsely granular, disorganized, walls break easily.
Saccharin	0.2	13.3	Hyphae enlarged, some much swollen, slight distortion; protoplasm clear, homogeneous; conidia phores thick, stunted.
Salicylic acid.....	0.2	15.2	Hyphae and conidia swollen, some of the conidia much elongated, few septa, tips blunt; protoplasm coarsely granular, disorganized, also the walls.
Sodium salicylate.	0.2	9.5	Hyphae as wide as germinated conidia, few septa granular protoplasm.
Alternaria:			
Alcohol	5.0	...	Hyphae swollen, septation reduced; protoplasm coarse, disorganized.
Benzoic acid	0.02	...	Hyphae enlarged, protoplasm and walls disorganized.

Histological Features—Continued

Agents		Size of germ. conidia in μ	Characteristics of development
Kind	Per cent		
Sodium benzoate	0.03	...	Hyphae enlarged, protoplasm and walls disorganized.
Boric acid	0.2	...	Hyphae enlarged, protoplasm weakened, has clear appearance.
Borax	0.5	...	Hyphae much weakened, protoplasm reduced.
Creosote	0.05	...	Hyphae slightly enlarged, protoplasm and walls disorganized, septation reduced.
Formaldehyde	0.1	...	Some hyphae swollen, others shrunken, hazy appearance; protoplasm badly disorganized.
[fol. 992]			
Formic acid	0.2	...	Hyphae enlarged, protoplasm and walls disorganized.
Sodium formate	0.5	...	Hyphae enlarged, protoplasm and walls disorganized.
Saccharin	0.3	...	Normal size, protoplasm non-hyaline, swollen appearance.
Salicylic acid	0.05	...	Normal size, protoplasm non-hyaline, swollen appearance.
Sodium salicylate	0.05	...	Some hyphae swollen, protoplasm disorganized.
Oidium:			
Alcohol	5.0	...	Hyphae swollen, septation reduced; protoplasm coarse, disorganized.
Benzoic acid	0.02	...	Hyphae slightly swollen, walls and protoplasm weakened, break easily. Some hyphae entirely disorganized, protoplasm reduced, coarsely granular.
Sodium benzoate	0.03	...	Hyphae slightly swollen, walls and protoplasm weakened, break easily.
Boric acid	0.2	...	Hyphae enlarged, protoplasm weakened, has clear appearance.
Borax	0.5	...	Hyphae much weakened, protoplasm reduced.
Creosote	0.05	...	Size normal, but disorganized appearance, septation reduced.
Formaldehyde	0.1	...	Some hyphae swollen, others shrunken, hazy appearance; protoplasm badly disorganized.
Formic acid	0.2	...	Hyphae enlarged, protoplasm and walls disorganized.
Sodium formate	0.5	...	Hyphae enlarged, protoplasm and walls disorganized.
Saccharin	0.3	...	Normal size, protoplasm non-hyaline, swollen appearance.
Salicylic acid	0.05	...	Normal size, protoplasm non-hyaline, swollen appearance.
Sodium salicylate	0.05	...	Some hyphae swollen, protoplasm disorganized.

The results of the tests with these preservatives show the acid to be stronger in all cases than the corresponding

salt,[1] and also that the benzoic acid was the strongest antiseptic in its action on the three moulds. In testing the preservatives in this group, the ordinary beef gelatin and tomato gelatin were used as well as the tomato bouillon, but the gelatins were found unsatisfactory on account of irregularity in development. The gelatins permitted only a surface growth, which limited the absorbent action of the hyphae to the part in contact only, whereas, in the solution the entire surface of the hyphae acts as an absorbent. The sodium benzoate, as it was the most generally used preservative, was tested under a greater variation of conditions than the others, and presented many peculiar features. In some cases, the development might show a greater retardation, but less effect on structure, than in others where the development seemed more nearly to approach the normal in extent, but on microscopic examination a more marked effect on structure could be seen. In some tests where the smaller amounts of preservative were used, the disorganization of both the protoplasm and the cell-walls in the early development was as great as with the larger amounts, while the later development might

[1] E. L. Trouessart: Antiseptic Therapeutics, Vol. 1, 1893. Trans. by E. P. Hurd.

[fol. 993] Results of Germination Tests—Continued

Cultures from Which Inoculations Were Made. Development in Normal Solution.

Agents		Number of days in contact with agent	No. of days to		
Kind	Per cent		Germinate	Form condia	Mature
Sodium benzoate	0.2	14	2	3	5
Sodium benzoate	0.2	423	...	...	...
Sodium benzoate	0.2	590	...	...	...
Sodium benzoate	0.5	14	4	5	...
Sodium benzoate	0.5	423	...	...	...
Sodium benzoate	0.5	590	...	...	...
Boric acid	0.1	14	1	3	4
Boric acid	0.2	14	2	4	5
Boric acid	0.2	423	...	...	...
Boric acid	0.5	590	...	...	...
Boric acid	0.5	14	5	...	...
Boric acid	0.5	423	...	...	...
Boric acid	0.5	590	...	...	...
Borax	0.1	14	2	3	4
Borax	0.2	14	2	3	5
Borax	0.2	423	...	...	...
Borax	0.5	14	...	...	...
Borax	0.5	423	...	...	...
Borax	0.5	590	...	...	...
Formic acid	0.2	423	3	4	6
Formic acid	0.2	590	...	...	...
Formic acid	0.5	423	...	...	...
Formic acid	0.5	590	...	...	...
Formic acid	1.0	9	...	...	...
Formic acid	1.0	108	...	...	...
Sodium formate	0.2	423	3	7	9[1]
Sodium formate	0.2	590	...	...	...
Sodium formate	0.5	423	3	4	6
Sodium formate	0.5	590	...	...	...
Salicylic acid	0.1	14	1	3	4
Salicylic acid	0.2	14	1	3	...
Salicylic acid	0.2	423	5	7	12[2]
Salicylic acid	0.2	590	7	...	...
Salicylic acid	0.5	14	...	...	...
Salicylic acid	0.5	423	...	...	...
Salicylic acid	0.5	590	...	...	...
Sodium salicylate	0.1	14	1	3	4
Sodium salicylate	0.2	14	1	3	4
Sodium salicylate	0.2	423	3	4	6
Sodium salicylate	0.2	590	5	8	9
Sodium salicylate	0.5	14	1	3	5
Sodium salicylate	0.5	423	3	4	6
Sodium salicylate	0.5	590	4	5	7
Saccharin	0.1	14	2	3	4
Saccharin	0.2	14	2	2	4
Saccharin	0.2	423	3	4	6
Saccharin	0.2	590	3	7	13
Saccharin	0.5	14	1	2	4
Saccharin	0.5	423	3	4	6
Saccharin	0.5	590	5[3]	...	...
Saccharin	1.0	8	2	5	7

[1] Curled. [2] Surface yellow. [3] Wet curled masses on surface.

[fol. 994]

Agents		Number of days in contact with agent	No. of days to		
Kind	Per cent		Germinate	Form condia	Mature
Saccharin	1.0	107	3	5	8
Saccharin	1.0	590	5	...	...
Saccharin	2.0	21	3	7	8
Sodium sulphite	0.1	14	3	3	5
Sodium sulphite	0.2	14	2	2	5
Sodium sulphite	0.2	423	3	...	12[1]
Sodium sulphite	0.2	590	7	...	...
Sodium sulphite	0.5	14	...	...	...
Sodium sulphite	0.5	423	2	8	12[2]
Sodium sulphite	0.5	590	3	9	13[3]
Copper sulphate	0.1	14	3	4	5
Copper sulphate	0.2	14	2	3	4
Copper sulphate	0.2	423	2	3	4
Copper sulphate	0.2	590	7	...	...
Copper sulphate	0.5	14	2	3	4
Copper sulphate	0.5	423	2	3	6
Copper sulphate	0.5	590	3	5	7
Copper sulphate	1.0	21	...	...	...
Copper sulphate	1.0	28	...	...	...
Copper sulphate	1.0	117	...	...	...
Alum	1.0	35	2	4	6
Alum	1.0	134	3	5	6
Creosote	0.02	28	2	2	4
Creosote	0.02	127	3	5	6
Creosote	0.04	25	2	3	4
Creosote	0.04	124	5	6	8
Formaldehyde (40 per cent)	0.02	14	2	2	3
Formaldehyde (40 per cent)	0.02	118	2	3	6
Formaldehyde (40 per cent)	0.04	19	2	2	4
Formaldehyde (40 per cent)	0.04	117	1	3	4
Formaldehyde (40 per cent)	0.1	8	...	...	...
Formaldehyde (40 per cent)	0.1	21	...	...	...
Formaldehyde (40 per cent)	0.1	28	...	...	...
Formaldehyde (40 per cent)	0.2	21	...	...	...
Formaldehyde (40 per cent)	0.2	28	...	...	...
Zinc chlorid	0.1	34	2	3	4
Zinc chlorid	0.1	132	3	5	7
Zinc chlorid	0.1	202	2	6	8
Zinc chlorid	0.2	34	2	3	4
Zinc chlorid	0.2	132	3	6	7
Zinc chlorid	0.2	202	3	4	6
Oxalic acid	0.5	28	2	3	4
Oxalic acid	0.5	127	2	5	6
Oxalic acid	0.5	197	2	3	5
Oxalic acid	1.0	25	2	3	4
Oxalic acid	1.0	124	3	6	7
Oxalic acid	1.0	194	2	6	8
Tannic acid	3.0	28	2	2	4
Tannic acid	3.0	127	3	5	7
Tannic acid	3.0	197	3	4	7
Carbolic acid	0.02	8	2	2	3
Carbolic acid	0.02	107	2	3	5
Carbolic acid	0.04	8	2	4	4
Carbolic acid	0.04	177	2	3	4

[1] Yellow. [2] Yellow. [3] Yellow. [4] Tiny compact submerged colonies.

[fol. 995] enlargement, accompanied by disorganization of the protoplasm and walls. The mustard produced starvation and also disorganization of the protoplasm, as indicated by the stunted and distorted hyphae, the swollen and non-hyaline appearance of the protoplasm, and the tendency in the Penicillium to form fruiting heads almost directly from the hyphae developed from the germinated spore. The hyphae formed matted tufts, difficult to separate, and with blunt distorted fruiting heads. A peculiarity of the mustard was that the active principle causing the abnormal growth produced the effect when present in minute quantities, as in the 0.1 per cent solution of the ground mustard and the 1 per cent of seeds. Stevens' working on P. crustaceum states that "peculiar knotted or twisted hyphae frequently result from the attempt to grow in a poisonous solution." Clark used P. glaucum and found that the effect of deleterious agents on the mycelium was "varied and often characteristic."

The ordinary acids—citric, lactic, and malic—which are present in fruits and vegetables, caused only a slight retardation in development when as large an amount as 6 per cent was used, which is more than occurs in fruits other than the lemon. More than this amount apparently checked metabolism, as shown in the reduced and impoverished appearing protoplasm. The tartaric acid was much stronger, the 4 per cent solution, while only slightly retarding development, caused stunting, lesser amounts causing swelling and disorganization. The other organic acids—acetic, benzoic, boric, butyric, and salicylic—and their sodium salts caused a complete disorganization of both the protoplasm and walls. There was a decided retardation of development by even small amounts, and in some of them a yellowing or browning of the protoplasm. In the extreme stages the hyphae were much swollen, and filled with a coarsely granular, non-hyaline mass, showing no distinction of ectoplast, and on rupture, spreading as a disintegrated mass.

The salts of the metals produced much the same results, though not so extreme in either swelling or disorganization, and with amounts that were not so close to the inhibitive

---

[1] Botanical Gazette, Dec., 1898.

points. When the larger amounts were used, and germination much delayed, stunted, curled colonies were developed with attenuated, hyphae, and apparently coagulated protoplasm. Similar changes resulted with the lesser amounts when germination was delayed by low temperature.

Swelling by the lesser amounts, and stunting by the greater were also produced by carbolic and the mineral acids, creosote, mercuric chlorid, and the alkaloids. Mercuric chlorid and the alkaloids caused disorganization of the protoplasm, shown at first by the full, granular, nonhyaline appearance with no distinction of limiting membrane and plasma, followed by the reduction of the plasma to a thin layer, containing few granules.

The alcohol retarded development, producing swelling, accompanied by distortion and hardening; in some cases a shrinking without distortion occurred, and in others disorganization.[1]

There were also some peculiar effects, such as the formation of fruiting heads in the Pencillium, formed directly from the primary hyphae and in the Alternaria a long chain of conidia, the formation of an abnormally large

---

[fol. 996] TRANSLATION OF DEFENDANT'S EXHIBIT No. 18

Chemistry of Plants. Action of Boric Acid on Germination. J. Morel

Comptes-Rendus Hebdmadaires de l'Academie des Sciences 1892, Vol. 114, pp. 131-133

According to an experiment made by Peligot on a plot of beans (Comptes-Rendue vol. 83, p. 686) a very strongly diluted solution of boric acid used for sprinkling purposes is said to cause the rapid decay of the vegetables.

I have examined the action of boric acid on the phenomenon of the germination of beans and wheat kernels, by bringing the seeds into contact during varying lengths of time with more or less concentrated solutions of this acid.

---

[1] Dujardin—Beaumetz and Audigé: Experimental researches on the toxic power of the alcohol. 1879.

In a first experiment I left the beans soak for 6 hours in boric acid solutions containing, respectively, 1, 2, 5 and 10 thousandths of this acid. The seeds were then left to germinate at a mild temperature in moist sand. In the tests with 1 and 2 tenths of 1% of acid the embryo developed nearly normally; the rootlet emerged on the third day, the same as with the witness seeds. In the 0.5% test there was a delay of 2 to 3 days in the appearance; the 1.0% test had given nothing even on the 6th day, the evolution of the embryo had remained stationary.

The seeds of these various tests were then sown and left to themselves. The test with 0.1% of acid showed its cotyledons already on the third day; the 0.2% test on the fifth day; in the 0.5% test they appeared only on the 8th day and still later in the 1.0% test. It has been observed [fol. 997] that thirty-six days after the planting the 0.1% test gave green and vigorous plants which differ in no respects from the normal witness plants grown in the same time; in the 0.2% test the plants were a trije less vigorous and less strongly foliated than in the preceding test; the leaves remained for some time yellowish whereupon they gradually turned to a green; the 0.5% test gave rather sickly looking plants, with small and yellow leaves; an accident prevented us from following up their complete evolution; the 1.0% test gave nothing but very weak and etiolated plants, the growth of which has been very slow and little regular; the seminal leaves stayed for a long time with a yellow tint; the normal leaves stayed very small and were few in number, and after two months their growth is still miserable in spite of a real improvement. In the latter case a certain part of the seeds only gave living plants; the others perished.

Another series of tests was made by letting the beans soak in a 1% boric acid solution during 3, 2 and 1 hour. After having been held for 3 days in moist sand at a gentle temperature the embryons of the seeds of the 1 hour test were apparently the only ones to become visible on the outside, the other remained stationary. On being placed in soil the seeds of these various tests developed their seminal leaves only with extreme slowness. After one month in the 1 and 2 hour soaking test there were some sickly-looking plants with small and yellow leaves; the 3 hour soaking test resulted in a very small number of even more miserable

plants which scarcely showed above the ground. Two weeks later the plants developed from seeds which had been soaked one hour lived with some degree of strength but their leaves remained yellowish and smaller than the normal leaves.

In these two series of tests the beans prior to being subjected to the action of the boric acid solution had previ- [fol. 998] ously been immersed for 6 hours in ordinary water in order to render them more readily permeable.

In a 3rd test beans were directly buried into the ground which had remained in contact with a 1.0% boric acid solution during one hour, 30 minutes and 15 minutes, respectively, but which had not undergone the preliminary immersion.

The seeds which had been soaked for 15 and 30 minutes developed their seminal leaves from the fourth to the sixth day; the seeds of the 1 hour soaking test developed them only after a delay of 2-3 days. One month after planting them into the soil the first test beans gave plants exhibiting an apparently normal vegetation; those of the second test differed therefrom only by the color of their leaves which was a paler green; the third test beans retained slightly yellowish and smaller leaves. After 40-45 days of germination there was hardly any difference left between the plants from these various tests.

Tests similar to the above, but with a 1% borax solution (corresponding to a 0.36% boric acid solution), gave with beans results which were in every respect comparable with those obtained with the 1.0% boric acid solution; the plants which did not perish were perhaps slightly more green and a little more sturdy and came nearer to a normal growth.

The foregoing tests carried out with wheat grains gave results similar to those observed with the beans; the growth after the planting in the soil may have proceeded at a faster rate and been slightly more vigorous; i. e. the wheat grains seem to have resisted the anti-germinating action of the boric acid and of the borax better than the beans.

To sum up, one can conclude from these experiments that boric acid in a state of solution, on being brought into contact with vegetable seeds, impedes and even prevents completely the phenomena of germination provided the con- [fols. 999 & 1000] tact is sufficiently prolonged or the solu-

tion concentrated enough. This inhibiting action becomes weaker and even disappears in proportion to the duration of the contact and the strength of the solution. Finally, this action is not absolutely the same for the various vegetable seeds and can vary with these.

The action of borax is altogether comparable with that of boric acid under the same conditions which seems to indicate that soda acts here in the same way as boric acid.

One is now in a position to predict—and I am carrying out a certain number of experiments along these lines—that boric acid acts strongly on the lower fungi and related organisms, the growth of which will probably be completely inhibited by even very weak solutions.

If these assumptions shall be corroborated by facts boric acid will be able to take a place by the side of copper sulfate to combat the mildew of the grape-vine and the smut of wheat, perhaps also anthracnose, oidium and other diseases due to cryptogamis organisms which infest useful plants.

[fol. 1001] DEFENDANT'S EXHIBIT No. 19

United States Patent Office

Lewis H. Spear, of Braintree, Vermont

Improvement in Preserving Animal and Vegetable Substances

Specification Forming Part of Letters Patent No. 67921, Dated August 20, 1867; Antedated August 15, 1867

To all whom it may concern:

Be it known that I, Lewis Hobart Spear, of Braintree, in the county of Orange and State of Vermont, United States of America, have invented or discovered a new and Improved Mode of Preserving Animal or Vegetable Matter, whether fluid or solid, in a wholesome and edible condition for food or for beverage without material loss or change of its natural flavor; and I do hereby declare that the following is a full, clear, and exact description of my said invention or discovery.

After many years of careful and laborious experiments with various antiseptic materials known to be friendly to man when taken into his stomach with food, I have discovered that animal or vegetable matter, either solid or fluid, when subjected to the action of either of the herein-named solutions, can be preserved in a wholesome and edible condition for food or for beverage without material loss or change of its natural flavor.

The nature of my invention or discovery consists, first, in subjecting animal or vegetable matter to the action of a solution of a mixture of boracic acid and sulphurous acid, in connection with an alkali and water, for the purpose of preserving the said animal or vegetable matter in a pure and wholesome condition for food; second, in subjecting animal or vegetable matter to the action of a solution of sulphurous acid, in combination with an alkali and water, for the purpose of preserving the said animal or vegetable matter in a pure and wholesome condition for food; third, in subjecting animal or vegetable matter to the action of a solution of boracic acid, in combination with an alkali and water, for the purpose of preserving the said animal or vegetable matter in a pure and wholesome condition for food; fourth, in subjecting or animal or vegetable matter to the action of a solution of boracic acid in water, for the purpose of preserving the said animal or vegetable matter in a pure and wholesome condition for food.

The object of my invention or discovery is to supply, at comparatively small cost, a wholesome and agreeable food to persons living in densely-populated countries or cities, from other and remote localities, where the population is sparse, and where flesh, fish, fowl, fruit, and vegetables are abundant and cheap; and also to preserve matter of domestic production or use in a sweet and wholesome condition through such seasons of the year, and through such periods of time, as would under ordinary circumstances, produce fermentation and putrefaction.

Having stated the nature of my invention or discovery, and its chief objects, I will proceed to describe the manner in which I have carried it out; and, for the convenience of reference, I will designate by number the different preserving solutions which I make and use.

Solution No. 1.—The solution of a mixture of boracic acid and sulphurous acid, in connection with an alkali and water, I make in the following manner: I first make a saturated solution of good commercial borax in water, and then force into the said saturated solution a stream of sulphurous-acid gas by means of a pump and pipe connected with the dome of a furnace where I burn the sulphur to generate the said gas, and I continue to force said gas into the said solution until it is rendered neutral, which I determine by testing with litmus paper in the usual way.

Solution No. 2.—The solution of sulphurous acid, in combination with an alkali and water, I make by dissolving fine crystals of sulphite of soda in water until the specific gravity of said solution will mark from five to thirty-five degrees by Baumé, according to the strength or specific gravity desired, and I neutralize said solution with sulphurous acid.

Solution No. 3.—The solution of boracic acid, in combination with an alkali and water, I make by dissolving good commercial borax in water until the said solution is saturated, and I neutralize said solution with boracic acid.

Solution No. 4.—The solution of boracic acid and water I make by dissolving the pure crystals of boracic acid in water to saturation.

The antiseptic power of each of the above-named solutions may be diminished or increased by diminishing or increasing its specific gravity.

The before-named solution No. 1 may be made by dissolving the crystals of borax and the crystals of sulphite [fol. 1002] of soda in water, and then neutralizing said solution with sulphurous acid; but I prefer making said solution in the manner hereinbefore stated.

For preserving animal matter I prefer to use solution No. 1, and for preserving vegetable matter I prefer to use solution No. 2; but I have had good results from the use of the other solutions.

Any animal whose meat I wish to preserve may be killed and dressed in the usual way, and cut into pieces of the same dimensions as those usually cut for making salt beef. The said pieces I immerse for twenty-four hours or more

in a bath made of solution No. 1, diluted with water till its specific gravity marks 5° by Baumé, contained in a wooden cistern, or other suitable vessel, of capacity sufficient to allow the said pieces to be completely covered by the said solution. After being immersed twenty-four hours or more, I take said pieces out of said solution and put them into ordinary beef-barrels, or other suitable vessels, taking care to leave sufficient room in said barrels to allow said pieces placed therein to be completely covered by a fresh quantity of solution No. 1 of 5° by Baumé, which I pour into said barrels and over said pieces. Said barrels are now headed up in the usual manner, and so kept till the said pieces are wanted for the table for food, when they may be taken out, rinsed in fresh water for a minute or two, and cooked in any manner desired.

Fish, fowl, birds, and all similar animals, may be preserved in the manner above stated for preserving meat.

When I desire to preserve animals entire to be used as food I proceed as follows: The animal is bled by severing one of the carotid arteries, and its body suspended in a vertical position by the hind legs, that the discharge of blood may be rapid and complete. Immediately after the blood has been discharged I lower the body of the animal to a horizontal position, and elevate the head and especially the nose, so that said head shall be higher than the body. I do this for the purpose of preventing the escape and waste of the preserving solution through the lungs and windpipe at the nostrils. Into that part of the severed artery leading in the direction of the heart I insert a tube or pipe, and firmly secure it there by a suitable ligature, for the purpose of preventing any escape of the solution at the joining of said artery and tube. The other part of said severed artery leading in the direction of the head I firmly close by a suitable ligature, to prevent any flow and waste of the solution from that direction. Then, with a suitable pump or equivalent means, either of the above-named solutions, but, by preference, solution No. 1 of specific gravity 5° by Baumé, is injected until the arteries and veins are completely filled, the solution being kept all the time during the operation of injecting at a temperature of 100° by Fahrenheit, by means of a coil of pipe heated by steam or other suitable means. For every pound of the "live

weight'' of the animal I inject two ounces of the said solution. The skin or hide of the animal should not be removed until the flesh has absorbed the solution, which will require from thirty minutes to three hours, according to the weight and bulk of the animal. After a sufficient time has elapsed for the absorption of the solution I again suspend the animal and remove the hide and entrails in the ordinary way.

Meat thus prepared will keep sweet for a long time even in hot climates; but when I wish to keep it for years I cut it in pieces and pack in barrels, and cover it with a solution of the same kind and of the same specific gravity as that which was injected into it.

Birds or fowl whose live weight is more than one pound, or whose arteries are large enough to permit of their being injected, may be preserved entire by injecting into their arteries and veins the same kind of solution, and the same quantity for every pound of the live weight of said birds or fowl, that I use for preserving meat, as hereinabove stated.

Birds or fowl whose live weight is less than one pound, or whose arteries are too small to permit of their being injected, may be preserved entire by injecting said solution into their crops and intestines, using the same kind of solution, and the proportionate quantity, as above stated, for meat.

To preserve oysters I thoroughly mix with them three ounces of solution No. 1, of specific gravity 5° Baumé, for every pound of said oysters.

To preserve lobsters I boil them from thirty to forty minutes in solution No. 1, of specific gravity 5° Baumé, and then pack in suitable vessels and cover them with said solution, same as cut meats.

Animal substance treated as above directed remains sweet for a long time after it is cooked. When it is designed to supply people on a journey, or an army on the march, it can be cooked and put in suitable vessels and covered with the soup, as fruit is with sirup.

To preserve milk, say for six days, I mix with it twenty-five ounces of solution No. 1, specific gravity 5° Baumé for every one hundred pounds of milk, and to preserve one hundred pounds one month I mix with it fifty ounces of said solution, and the same proportion for a longer time.

If the above solution is made to mark 18° by Baumé instead of 5°, a much less quantity of said solution may be used, six and one-fourth ounces of 18° Baumé being equal to twenty-five ounces of 5° Baumé.

In preserving fruits and vegetables it is best to prepare them in the manner heretofore practiced for preserving them in hermetically-sealed vessels, by cooking them in a little less than if to be immediately used on the table, or until they are completely scalded through. Then take the [fol. 1003] partially-cooked vegetable or fruit out of the kettle in which they have been scalded and place them in the vessels in which they are to be kept, leaving the juice or sirup in which they were scalded in said kettle. Now, add to said juice or sirup one ounce of solution No. 2, specific gravity 18° Baumé, for every eight pounds of said vegetable or fruit, with the juice, weighed before scalding, and thoroughly mix said solution with said sirup or juice; then pour said juice or sirup upon the said scalded vegetable matter or fruit until it is completely covered; then cork the vessels containing said vegetable matter, or cover said vessels with cloth or paper, to keep out dust and insects. If there is not sufficient juice or water left in said kettle after removing said vegetable matter to cover the said fruit or vegetables, water must be added, when the said solution is introduced and well mixed with said solution.

In making sauce of small fruits the said solution No. 2, specific gravity 18° Baumé, may be added to the said fruit while in the kettle, and well mixed.

Tomatoes, to be preserved, should be first scalded and peeled, and then put into the kettle and kept boiling until well cooked, and care should be taken to stir them well after the solution is added, that said solution may completely permeate them.

Cider or wine, after attaining the flavor desired, may be preserved by adding the above solution No. 2, specific gravity 18° Baumé, at the rate of one ounce of said solution to three gallons of said cider or wine. Cork tight, and set away in cool place.

When it is desired to preserve animals entire, and not to be used for food, but for specimens or for dissection, and where the flavor is not important, I proceed as follows: I take any desired quantity of solution No. 2, and, putting it

into any suitable vessel, I then force into the said solution a stream of sulphurous-acid gas, by the same means hereinbefore stated for making said solution, until the said solution is completely saturated with the said sulphurous-acid gas, making what I call my concentrated preserving-solution.

Animals entire may be preserved by injecting said concentrated solution into their arteries and veins in the manner hereinbefore described; and human bodies may be embalmed by injecting the said concentrated preserving solution into their arteries and veins; but when I wish to preserve a human body for a great length of time, or for years, about three days after the said concentrated solution has been injected I inject a fresh supply of the said solution, equal in quantity to the first, or about ten per cent, by weight, of the said solution to the weight of said human body.

Animal or vegetable substances, when treated in the manner as herein described, may be preserved in vessels that are not hermetically sealed, but completely sealing said vessels is not objectionable.

The water used in making the above-named solutions should be pure.

If desired, the above-named solutions may be sweetened with sugar or honey, and flavored with spices to taste, without detriment to their antiseptic powers.

When fruits are required to be preserved in sirup, one dram of solution No. 2, specific gravity 18- Baumé, should be added and mixed with each pound of sirup.

I neutralize my preserving-solutions, except the boracic acid and solution No. 4, for the purpose of preserving the natural flavor of the matter subjected to their action.

The specific gravities herein named, and the degrees of temperature herein stated, and the proportions of preserving-solution herein directed to be used to the pound or any other named quantity of matter to be treated, are not rigid, and each or all of them may be varied considerably without seriously affecting the results.

Porcelain-lined vessels are preferred for mixing the said preserving-solution with vegetable matter while hot, and glass or stoneware vessels should be used, though wooden vessels will answer for keeping said vegetable matter in after having been mixed with said solution.

I have used my said preserving-solutions at various degrees of heat, from 60° Fahrenheit to the boiling-point of said solutions, but, with my present experience, I prefer to use said solutions, when treating animal matter with them, at a temperature of 100° or 110° Fahrenheit; but in treating fruit and vegetables I use them at a temperature of 212° Fahrenheit.

I do not intend to confine myself to the use of soda in connection or in combination with sulphurous acid, nor to soda in combination or connection with boracic acid, because many other compounds of sulphurous acid and many other compounds of boracic acid will answer the same purpose very well; but at present I prefer to use sulphite of soda and biborate of soda, (borax,) as hereinbefore stated. Neither do I mean to confine myself to the use of sulphurous acid or boracic acid to neutralize the before-named solutions, as other acids will answer; but at present I prefer to use the acids above-named for that purpose.

What I claim as my invention or discovery, and desire to secure by Letters Patent, is—

1. Subjecting animal or vegetable matter to the action of a solution of a mixture of borax (biborate of soda) or any other compound of boracic acid in connection with sulphite of soda or any other compound of sulphurous acid, in the manner substantially as herein described, for the purpose herein specified.

2. Subjecting animal or vegetable matter to the action of a solution of sulphite of soda or any other compound of sulphurous acid, in the manner substantially as herein described, for the purpose herein specified.

[fol. 1004] 3. Subjecting animal or vegetable matter to the action of a solution of borax (biborate of soda) or any other compound of boracic acid, in the manner substantially as herein described, for the purpose herein specified.

4. Subjecting animal or vegetable matter to the action of a solution of boracic acid, in the manner substantially as herein described, for the purpose herein specified.

L. H. Spear.

Witnesses: Wm. Dean Overel, A. V. Briesen.

[fol. 1005] DEFENDANT'S EXHIBIT No. 20

United States Patent Office

Wilton C. Donn, of Washington, District of Columbia, administrator of Henrik Gahn, Deceased, Assignor to Charles G. Am Ende, of Hoboken, New Jersey.

Improvement in Conpositions for Preserving Food

Specification Forming Part of Letters Patent No. 161,944, Dated April 13, 1875; Application Filed October 14, 1874

Case C

To all whom it may concern:

Be it known that Henrik Gahn, deceased, late of Upsala, in the Kingdom of Sweden, invented a new and Improved Composition for Preserving Raw and other Food, of which the following is a specification:

This invention relates to a new composition by which all kinds of raw food, fruit, and other vegetable products may be preserved for a longer time, and in warm climate; and the invention consists in compounding boracic acid and alum in the proportion of about twenty parts of boracic acid and ten parts of alum.

This composition may be used in a powdered state, and then rubbed and sprinkled over layers of the substance to be preserved, or in a liquid state, and then the substances to be preserved have to be dipped or immersed into the liquid. For this solution I prefer to use from eight to ten ounces of the powder to one gallon of water, or as much as the water will dissolve. Sugar in the proportion of about two parts to ten parts of alum and twenty of boracic acid may be also used to advantage, in addition to the ingredients named, and the proportion of the alum may be varied according to the amount of substances to be preserved, some kinds requiring but one part of alum to twenty of boracic acid, and some as much as ten parts of alum to twenty of boracic acid.

I do not claim the composition of boracic acid, gum-tragacanth, salt, chloric acid, alum, and sugar claimed in the patent to H. Galm, dated January 25, 1870, and numbered

99,180, for this invention is a simplification and improvement on such composition; but

I do claim as the invention of Henrik Gahn——

The composition of boracic acid and alum, as and for the purpose described.

In testimony that I claim the foregoing as the invention of Henrik Gahn, I affix my signature in presence of two witnesses.

Wilton C. Donn, Administrator.

Witnesses: J. McKenney, A. Moore.

[fol. 1006] DEFENDANT'S EXHIBIT No. 21

United State Patent Office

Charles G. Am Ende, of Hoboken, New Jersey

Improvement in Compositions for Preserving

Specification Forming Part of Letters Patent No. 187,956, Dated March 6, 1877; Application Filed August 1, 1876

To all whom it may concern:

Be it known that I, Charles G. Am Ende, of Hoboken, in the county of Hudson and State of New Jersey, have invented a new and Improved Preserving Composition, of which the following is a specification:

This invention relates to a new composition for preserving all kinds of meats, vegetables, and the like, and for protecting the same against injury by germs of putrefaction.

The invention consists in compounding boracic acid, either in a liquid or pulverous state, with chloroform, in the proportion of about twenty parts of chloroform to five hundred parts of the boracic acid; but the proportion may be varied according to the nature of the substance to be preserved, and of the atmosphere to which the same is to be exposed.

In place of chloroform, chloral-hydrate, or other substance yielding chloroform on direct decomposition, may be used

with substantially the same effect, and, if desired, other salts may be added to the mixture.

The composition is applied to the substance to be preserved in substantially the same manner in which preservatives are usually applied. The chloroform, owing to its subtletly, enters the pores of the substances to be preserved, and prevents the formation of fungi or algæ therein and on the surface while the boracic acid prevents putrefaction chiefly by hindering the formation of bacteria.

I claim as my invention——

The composition of boracic acid and chloroform, or substance yielding chloroform, substantially as specified.

Chas. G. Am Ende.

Witnesses: A. V. Briesen, Ernest C. Webb.

[fol. 1007] DEFENDANT'S EXHIBIT No. 22.

United States Patent Office

Fabien Jourdes, of Paris, France

Improvement in Antiseptic Compositions

Specification Forming Part of Letters Patent No. 199,209, Dated January 15, 1878; Application Filed November 1, 1877

To all whom it may concern:

Be it known that I, Fabien Jourdes, of Paris, France, have invented a new and useful Improvement in Preserving Animal and Vegetable Matters; and I do hereby declare that the following is a full, clear and exact description of the same.

My invention consists in an improved compound for preserving animal matters such as greases, meats, butter, milk, fish, and leather, and also vegetable substances, such as oils and fruits.

The compound consists of equal parts of bisulphate of alumina and potash, or alum, pure sulphate of lime, and biborate of soda, or trade borax, the same being applied by sprinkling, coating, or impregnating the matters to be pre-

served with a dry mixture of the said salts, previously reduced to an impalpable powder, or by treating the substances in a solution of the same.

In carrying out my invention, the powdered compound is, when solids are to be preserved, sprinkled upon the same so as to form a coating. For preserving such substances as butter, the mass is to be mixed with a small quantity of the above-mentioned salts, and the surface in contact with the outer air is to be covered with a slight coating. When the butter is to be preserved for a short time only, it may be enveloped in a sheet of unsized paper, (filtering paper,) previously dipped into a concentrated solution of the three salts.

For preserving liquids, such as milk, &c., a small quantity of the powder is dissolved in the same.

Eggs are preserved by being plunged into a concentrated solution of the three salts, after which they will keep fresh for several months.

I ~~am aware of the fact that alum and borax have~~ been heretofore used in connection with each other in preserving compounds, and also that powdered sulphate of lime has heretofore been used for preserving purposes. I therefore lay no claim to either separately, but only when used in combination with each other, in the proportions stated.

Having thus described my invention, what I claim as new is—

The compound for preserving animal and vegetable substances, consisting of a mixture of alum, or bisulphate of alumina and potash, pure sulphate of lime and the biborate of soda, or trade borax, in about equal proportions, as described.

Fabien Jourdes.

Witnesses: Robt. M. Hooper, Eugene Helert.

[fol. 1008]. DEFENDANT'S EXHIBIT No. 23

United States Patent Office

Hugo Jannasch, of Bernburg, Germany, Assignor to Elizabeth Calm, of New York, N. Y.

Improvement in Preserving Compounds

Specification Forming Part of Letters Patent No. 216,414, dated June 10, 1879; Application Filed January 16, 1879; Patented in Germany, July 31, 1877.

To all whom it may concern:

Be it known that I, Hugo Jannasch, of the city of Bernburg, in the Empire of Germany have invented certain new and useful Improvements in Preserving Compounds, of which the following is a specification.

The object of this invention is to furnish an improved antiseptic compound by which fresh meats of all kinds, milk, butter, eggs, skins, fish, fruits, and vegetables may be preserved in superior manner, with great facility, and at a small expense. The compound may be applied either as a salt or in different degrees of solution, and has the advantage of exerting its influence in quick and permanent manner. It is perfectly odorless, and has only a slight salty taste, and neither impairs nor exerts the least deleterious influence upon the health of persons consuming the articles preserved therewith.

The invention consists of a preserving composition, which is prepared of chloride of potassium, nitrate of soda, and chemically pure boracic acid which ingredients are first dissolved in water, then mixed under exposure to heat, they forming, after the chemical reaction has taken place and the moisture is evaporated, an antiseptic salt, composed of hypo-nitrate of potash, hypochlorate of soda, borate of soda, borate of potash, and free boracic acid.

The preserving compound is prepared in the following manner and proportions: Equal parts of chloride of potassium, nitrate of soda, and chemically-pure boracic acid are dissolved in the proper quantities of water. The solution of chloride of potassium is then heated in a kettle up to the

boiling point, and then the solution of nitrate of soda added thereto. This solution is kept on a brisk fire until the lye has become perfectly clear. The solution of boracic acid is then added under continual stirring. By the influence of the boracic acid, at a temperature of 212° Fahrenheit, a reaction takes place, which is indicated by the mass assuming a yellowish color, and by the escape of chlorine gas. After the reaction has taken place the solution is slowly evaporated at a low temperature until a dry salt is obtained, which is composed of a combination of hyponitrate of potash, hypochlorate of soda, borate of soda, borate of potash, and free boracic acid.

This compound is applied to the articles to be preserved, either as a salt or in a more or less strong solution, according to the time for which the same are to be preserved, or in connection with sugar or salt, as the case may be. It may then be used for domestic, manufacturing, and all such purposes in which a reliable antiseptic preparation for the preservation of meats, fruits, vegetables, and other perishable articles is required, or the formation of infusoriæ or fermentation is to be prevented.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A preserving compound consisting of a chemical combination of hyponitrate of potash, hypochlorate of soda, borate of soda, borate of potash and free boracic acid, substantially as specified.

2. The process herein described of preparing an antiseptic preserve-salt; consisting in adding to a hot solution of chloride of potassium solutions of nitrate of soda and chemically-pure boracic acid, continuing the heat and evaporating the mixture after the chemical reaction has taken place at a low temperature to a dry powder, substantially as set forth.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two witnesses this 9th day of December, 1878.

Hugo Jannasch.

Witnesses: Gottfried Hermann Thieme, Henry Van Arsdale.

[fol. 1009] DEFENDANT'S EXHIBIT No. 24

United States Patent Office

Lorenzo Fagersten, of Chicago, Illinois

Improvement in Processes for Preventing Mold Upon Meats

Specification Forming Part of Letters Patent No. 221,541, Dated November 11, 1879; Application Filed July 30, 1879

To all whom it may concern:

Be it known that I, Lorenzo Fagersten, of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Process of Preventing Mold upon Meats; and I hereby declare the following to be a full, clear, and exact description thereof, which will enable others skilled in the art to which my invention appertains to use the same.

My invention relates to a process of preventing mold upon cured meats, more especially hams and shoulders; and it consists in immersing or dipping the meats in a hot solution of boracic acid or its salts, as hereinafter described and claimed.

It is well known that in the process of preparing smoked meats they are first picked or dry-salted and cured prior to being smoked, and that all pickled meats after being cured are drained of the pickle, and so permitted to remain for some time before being smoked, in order to attain the desired mellowness, and that during this time the meats are exposed to contact with the germs contained in the atmosphere.

The germs contained in the atmosphere, when in contact with the pickled and cured meats, generate a luxuriant and baneful growth of fungi, which if not checked in time, causes a decomposition of the meats. The usual practice is to wash off this fungus, mold, or slime from meats, such as shoulders hams, &c., before being smoked, with hot water, which, however, does not produce the desired result, from the fact that the germs, fungi, mold, or slime cannot be killed in any heat attainable by water in open vessels.

The object of my invention is to kill and remove from meats the said germs, fungi, mold or slime.

After the meats have been pickled and cured I immerse or dip them in a hot solution of boracic acid or its salts, as borax, boracite, and borocalcite, (whether or not the meats have previously been washed in water or pickle,) and prior to placing the meats in the drying-room or smoke-house.

Boracic acid and its salts are only slightly soluble in cold water, and their solubility increases rapidly with the increase of temperature of the water and when the solution is of about boiling heat it will not only kill all germs, fungi, mold, or slime that may have attached themselves to the meats, but adheres to the surface of the meats in the process of evaporation therefrom when placed in the drying-room or smoke-house, and so as to form a coating of crystallized boracic acid thereon, which, while perfectly innocuous, tends to prevent any further contamination from germs in the air, but does not prevent the drying or smoking of the meats in the usual manner.

In practice I prefer to use a solution of boracic acid at boiling heat; but the solution may be used with success if slightly varying therefrom, so long as it is hot.

I do not claim, broadly, the use of boracic acid or its salts, as I am aware they have been used in a powdered condition and in a cold solution, but am not aware that a hot solution of boracic acid or its salts has been heretofore used for the purpose of preventing mold upon meats.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

The process of preparing and preserving meats, which consists in first curing the meats in the ordinary manner by pickling, then dipping or immersing the same in a hot solution of boracic acid or its salts, and finally smoking the same.

Lorenzo Fagersten.

Witnesses: Wm. Zimmerman, James Howe.

[fol. 1010]: DEFENDANT'S EXHIBIT No. 25

United States Patent Office

Julius Hauff, of Feuerbach, Wurtemberg, Germany

Compound for Preserving Animal and Vegetable Substances

Specification Forming Part of Letters Patent No. 234,567, Dated November 16, 1880. Application Filed September 16, 1880. (Specimens)

To all whom it may concern:

Be it known that I, Julius Hauff, a citizen of Germany, residing at Feuerbach, Kingdom of Wurtemberg, Germany, have invented new and useful Improvements in Compounds for Preserving Animal and Vegetable Substances, of which the following is a specification.

My invention consists in a preserving compound produced by mixing boric acid and borax, then dissolving the mixture in water, and finally evaporating the solution to dryness.

The antiseptic or preserving qualities of boric acid and of borax are well known, and there is no doubt that the preserving qualities are due entirely to the boric acid contained therein. It appears probable, therefore, that boric acid will be more effective, under all circumstances, than borax corresponding to an equivalent quantity of boric acid. Such, however, is not the case when dry boric acid is employed, unless the circumstances are particularly favorable to bring the boric acid easily in complete solution. The reason of unsatisfactory results is found in the conditions for dissolving the boric acid, which in almost all cases are less favorable than those for dissolving borax, without regard to the fact that boric acid, on account of its fatty nature, is wetted with difficulty, and under certain circumstances, notwithstanding the presence of a surplus of liquid, no complete solution is effected.

In order to obtain a compound which is easily soluble I take two parts, by weight, of boric acid, and one part, by weight, of borax, dissolve the mixture in water and then evaporate the solution to dryness. The results of this

operation is a salt which is easly soluble in about ten parts of water, and which is easily wetted.

I have also obtained a good result by mixing three parts of boric acid with one part of borax, and then treating the mixture in the manner above described. The result obtained is much more soluble than pure boric acid, and it shows in the highest degree preserving qualities, rendering the same of great value for preserving animal or vegetable substances, either in a dry state or in solution. Instead of borax (biborate of soda) borates of soda of a higher order, such as tetraborate or pentaborate of soda, may be used, and in this case the proportion of boric acid to be added is slightly changed.

In preparing my compound I have found that a pretty large quantity of water contained in the borax and in the boric acid escapes, and from this fact it may be concluded that said compound is not a mere mechanical mixture, but a chemical composition. Alcohol dissolves boric acid out of this composition.

What I claim as new, and desire to secure by Letters Patent, is ——

A dry preserving compound, consisting of a salt formed by the chemical union of borax and boric acid, in the proportions substantially as specified.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

Julius Hauff.

Witnesses: W. Hauff, A. Hauff.

[fol. 1011] DEFENDANT'S EXHIBIT No. 26

William F. Grier, of London, England

Preservative for Organic Substances and Process of Making the Same

Specification Forming Part of Letters Patent No. 268,094, Dated November 28, 1882. Application Filed September 6, 1882. (No specimens)

To all whom it may concern:

Be it known that I, William F. Grier, of London, England, Kingdom of Great Britain, have invented certain

Improvements in Preservatives for Organic Subtsances and a Process of Making the Same; and I hereby declare the following to be a full, clear, and exact description thereof, sufficient to enable one skilled in the art to practice my invention.

My invention relates to a preservative for food and all other organic substances, and has for its object to provide a preservative which is easily and conveniently handled and transported, being a dry substance in impalpable powder, without the slightest tendency to change in itself in any climate or weather, while wholly lacking in bad or unwholesome results on the human economy, and having in the highest degree antiseptic or preservative properties.

My invention consists, first, in a process of making a preservative, hereinafter described, and in a novel preservative for organic substances, as hereinafter fully described, and specifically pointed out in the claims.

I take eleven hundred and sixteen parts, by weight, of boracic acid ($_2BO_3$) and three hundred and eighty-two, by weight, of prismatic borax, ($Na_2B_4O_7+10H_2O$,) both of which I previously purify by recrystallization. I grind them into an impalpable powder and then mix them intimately together. Having done this, I subject these powders, on trays or otherwise, to a temperature of about 212° Fahrenheit. At the expiration of from ten to fifteen minutes chemical action takes place between the two substances, the molecules rearrange themselves, and water is evolved to such an extent that the previously perfectly dry powders become absolutely wet. I then remove the superfluous moisture by passing over the powders a current of dry hot air, which has the effect of carrying off the water in a state of vapor, and leaves the new mixture in the condition of a dry granular powder, very convenient for packing and remarkably handy for use in its various applications. On weighing the resultant compound it will be found that one-half of the water (H_2O) of crystallization of the borax ($Na_2B_4O_7$) has disappeared and one-third of that of the boracic acid (H_3BO_3.) The amount of water evolved amounts to nearly one-third of the total weight.

Each of the elements entering into the formation of a chemical compound has a definite atomic weight, and it will be found that the sum of the atomic weights of the elements forming the boracic acid amounts to sixty-two, and

that of the prismatic borax three hundred and eighty-two. Now, as the chemical combination of compounds takes place only in the proportion of the sums of the atomic weights of these compounds or multiples of them, I take a multiple (eighteen) of the molecular weight of boracic acid and the unit molecular weigth of the compound prismatic borax and treat them as before specified. The reaction that takes place may be represented as follows: $18H_3BO_3+Na_2B_4O_7 10H_2O=(9B_2O_3 9H_2O)\ (Na_2O 2B_2O_3 5H_2O)+23H_2O$.

The borate salt thus obtained is in a form readily transportable and in a convenient condition of fine division to be rubbed on the article to be preserved. Its antiseptic properties are very great, and among a great variety of purposes for which it is useful it will be found particularly serviceable in preventing mold and mildew in tobacco manufacture.

If found desirable, this preservative I have described may be mixed with other antiseptics and used.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The hereinbefore-described process of obtaining a food-preservative, consisting essentially in heating together eleven hundred and sixteen parts, by weight, of boracic acid and three hundred and eighty-two parts of prismatic borax in a finely-divided condition and intimately commingled until the evolution of water has fully taken place, and then drying off the evolved water by means of a current of dry hot air, substantially as set forth.

2. As a preservative for food and organic substances, the product of the hereinbefore-described process of treating boric acid and borax.

William F. Grier.

Witnesses: R. K. Evans, H. B. Applewhaite.

[fol. 1012] DEFENDANT'S EXHIBIT No. 27

United States Patent Office

Ransom F. Humiston, of Boston, Massachusetts

Compound for Preserving Food

Specification Forming Part of Letters Patent No. 270,899, Dated January 23, 1883. Application Filed July 28, 1882. (No specimens)

To all whom it may concern:

Be it known that I, Ransom F. Humiston, of Boston, Massachusetts, have invented a certain new and useful compound to be used for preserving food and other organic substances, of which the following is a specification.

The compound in which my invention is comprised consists of borax, sulphite of calcium, or its equivalent in the form of bisulphite of calcium, salt, and glucose, taken in substantially the proportions hereinafter stated.

To fifteen liters of water I add borax sufficient to make a saturated solution at a temperature of about 15° centigrade. To this I add from one to two grams (more or less) of sulphite of calcium or its equivalent value in the form of bisulphite of calcium. The lime in this ingredient is precipitated on account of the superior affinity of the sulphurous acid for the soda with which it unites, and this precipitate can be separated from the solution by ordinary methods. To the foregoing I add salt in the proportion of from 0.06 to 0.18 kilogram, and I also add glucose in the proportion of 0.06 kilogram. The boracic acid of which the borax is mainly composed is a known and exceedingly-effective antiseptic and preservative. The sulphite of calcium is a valuable anti-ferment in the destruction of fungi, &c., and the salt and glucose enhance the antiseptic properties of the compound and also mollify its taste. The strength of the compound may, if desired, be reduced by the addition of water.

For convenience of handling and transportation, I preferably reduce the antiseptic solution to a solid homogeneous mass by evaporating the liquid portion, and I then bring the mass to the condition of a powder, which may be

dissolved in water whenever an antiseptic solution is needed.

In conclusion, I state that I do not claim the use, as an antiseptic or preservative agent, of any one of the hereinbefore-mentioned ingredients separately considered; but

What I do claim is—

The hereinbefore-described preserving compound, consisting of borax or biborate of soda, sulphite of calcium, salt, and glucose, taken in the proportions substantially as specified.

In testimony whereof I have hereunto set my hand this 27th day of July, A. D. 1882.

R. F. Humiston.

Witnesses: Ewell A. Dick, Walter Blandford.

[fol. 1013] DEFENDANT'S EXHIBIT No. 28

United States Patent Office

Carl Maria Pielsticker, of London, County of Middlesex, England

Antiseptic

Specification Forming Part of Letters Patent No. 281,554, Dated July 17, 1883. Application Filed November 29, 1882. (No specimens.) Patented in England October 30, 1882, No. 5,153

To all whom it may concern:

Be it known that I, Carl Maria Pielsticker, a subject of the Emperor of Germany, residing at Kilburn, in the city of London, county of Middlesex, and Kingdom of England, have invented a certain new and useful Antiseptic for Preserving Alimentary Substances, (for which I have applied for provisional protection in England, No. 5,153, dated October 30, 1882;) and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the preservation of alimentary substances by means of a novel antiseptic.

Many processes have been tried to preserve alimentary substances unaltered in a raw and uncooked state—as, for instance, raw meat and fish—by means of various antiseptics, but only with partial success. Almost invariably it has been found that when exposing substances thus treated to the action of atmospheric air decay and decomposition soon set in, particularly so when the antiseptics have been used as a watery solution. In other instances the natural color or the taste was changed to such an extent as to make the article unfit, or nearly so, as an article of food. No much better result has been obtained by inclosing substances treated with antiseptics in air-tight vessels, because such articles of food contained not only atmospheric air in their bones, pores, and tissues, but it was also impossible, except by the application of heat, to remove the air from the vessels in which the articles previously treated with antiseptics were to be kept.

I am also well aware that attempts have been made to preserve alimentary substances in vapors and gases of various kinds, but without any decided or commercial success.

I obtain the best results by using the following process in conjunction with my novel antiseptic, which I compose by melting together, say, twenty parts of boracic acid, eight parts of phosphate of soda, and two parts of formiate of soda; or I may compose my antiseptic, using as equivalents borax, phosphoric acid, and formiate of soda.

My novel antiseptic may be either used in a pulverulent solid form or in solution.

In carrying out my invention I proceed as follows: The articles to be preserved are either covered with the solid antiseptic for from thirty minutes to several hours, (according to the size or thickness of the article to be preserved,) or the antiseptic may be rubbed into the articles; or the latter may be immersed or impregnated in a closed vessel containing the antiseptic in solution by applying pressure by means of a force-pump or otherwise. I prefer to use a concentrated solution—say, one ounce of the antiseptic in twenty ounces of water, or stronger—which permits me to leave the articles to be preserved for a short time in such solution—say from fifteen minutes to two

hours—and still to obtain perfect results without the articles having the chance of taking up an undue and objectionable quantity of moisture, and at the same time losing a portion of their nutritious and savory juices. After the articles to be preserved have taken up a sufficient quantity of the antiseptic they are placed in air-tight vessels or chambers, having an inlet stop-cock near the top or upper end and an outlet stop-cock near the bottom or lower end, but preferably on the same side as the inlet-cock. The inlet-cock as well as the outlet-cock are both opened, and the inlet-cock connected with a gas-holder containing carbonic-acid or carbonic-oxide gas, or a mixture of them, or a mixture of neutral gases in which carbonic-acid or carbonic-oxide gases form one of the principal constituents. I prefer in this gas-holder a pressure of, say, one hundred pounds to the square inch. I now admit the gas into the chamber and allow it to blow for some time with great force through the chamber, finding its outlet at the second cock, which may be connected with a second or a series of preserving-chambers, in order to use over again and economize the gas. The effect is to remove the atmospheric air to the greatest extent from the chamber or vessel, as well as any of the germs, which otherwise would induce putrefaction.

In order to completely remove all the air from the chamber or the pores and the tissues of the articles to be preserved, the outlet-cock is closed and the gas allowed to assume a certain pressure inside the vessel, (which may be [fol. 1014] regulated according to a pressure-gage on the chamber or vessel,) so as to completely enter into the bones, pores, and tissues of the articles, and to mix with and to replace the air contained in them. The outlet-cock is then opened, the gas and air blown out for some time, and a like operation repeated, if desired. Finally, the outlet-cock is closed and sealed, and when the gas has assumed again a pressure of, say, five to ten pounds, or more, per square inch inside the chamber or vessel, the inlet-cock is then also closed and sealed and the contents of the vessel are now preserved for a lengthened period. Instead of following this process, the articles to be preserved may be placed in an airtight vessel, the latter to be filled entirely with the antiseptic in solution, and gas admitted by the inlet-cock. When a certain pressure has been obtained inside the vessel, and the solution therefore has entered

into all the pores and tissues of the articles, and also replaced the air contained in them in consequence of the pressure obtained by means of the gas, the solution is forced out by opening the outlet-cock, and the gas allowed to blow through the chamber for some time until all the surplus moisture is removed. The latter cock is then closed, and when again a pressure of, say, five to ten pounds, or more, has been obtained inside the preserving vessel the inlet-cock is then likewise closed.

For very large chambers, especially, and in which, for instance, whole carcasses of meat are to be transported raw and fresh across the ocean, I prefer to proceed as follows: The meat is immersed for say, ten minutes or more in a concentrated solution of my novel antiseptic, or impregnated by pressure or rubbed or sprinkled with the solid antiseptic. The carcasses are then placed in the preserving-chamber; by preference they are hung up in rows from the ceiling of the chamber, care being taken that they do not touch each other. Between each row of carcasses I place an inlet gas-cock, which, on opening the same, is made to blow or carry with it a small quantity of the antiseptic solution in the form of a very fine spray or mist into and through the chamber, in this way disinfecting the latter and the articles placed in it thoroughly, and finding its way out by an outlet-cock. I may use for this purpose apparatus similar to that used for filling soda-water bottles where water is impinged upon by carbonic-acid gas under pressure inside a closed tube, and blown or forced into the bottle; or I may use any apparatus which I may find suitable for the injection of the spray together with the gas. After a short time the supply of the antiseptic solution is shut off and dry gas allowed to blow through the chamber for some time, until all surplus moisture has been removed. Finally, the outlet-cock is shut, a moderate pressure of gas is allowed to accumulate and is maintained inside the chamber, and the inlet-cock then also closed.

I am well aware that boracic acid has been used in almost every conceivable form as an antiseptic, but, as far as I have been able to find out, never in combination or as a compound with phosphate of soda and formiate of soda, both of which I find to be essential to produce the effects which I desire and have described.

Having fully described my invention, what I desire to claim and secure by Letters Patent is—

The composition or antiseptic salt herein described, for preserving alimentary substances, consisting of boracic acid, phosphate of soda, and formiate of soda, or their described equivalents, the proportions being such as to produce a completely soluble and practically tasteless salt, as set forth.

Carl Maria Pielsticker.

Witnesses: William Edward Gengel, John Forster Lennox Sykes.

[fol. 1015] DEFENDANT'S EXHIBIT No. 29

United States Patent Office

Augustus Morris and James Augustus Parker, of Sydney, New South Wales

Preservative Coating for Foods

Specification Forming Part of Letters Patent No. 556,471, Dated March 17, 1896. Application Filed July 10, 1895. Serial No. 555,546. (No specimens)

To all whom it may concern:

Be it known that we, Augustus Morris and James Augustus Parker, of Sydney, in the Colony of New South Wales, have invented certain new and useful Improvements in Means for Preserving Fruit, Vegetables, Meats, &c.; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention relates to an improvement in means for preserving fruit, vegetables, meats, cheese, eggs, confectionery, and other vegetable or animal matter, the object of the invention being to envelop the fruit or other article in an artificial skin or coating to prevent the access of germs from the air, which germs, if permitted to penetrate

the natural skin of the food, would set up putrefactive fermentation.

A further object is to prevent the evaporation of the water from the juices of the fruit and prevent shriveling and toughening.

A further object is to prevent oxidation and consequent rancidity of ham and bacon.

A further object is to stop evaporation and early decay in cheese.

A further object is to close the pores of the shells of eggs, so that no evaporation nor absorption of oxygen or other external injurious agent can take place.

With these objects in view the invention consists in certain combinations of ingredients for forming an artificial skin or coating on fruit, &c., substantially as hereinafter set forth, and pointed out in the claims.

In carrying our invention into effect we dip the fruit or other food into a solution of such materials as will leave a tough elastic coating or artificial skin after the solvent shall have evaporated, or the fruit or other article can be coated with the solution by means of a brush or in any other desired manner.

Our improved solution is composed of water gelatine, (best,) dextrine, borax, glycerine, and unmethylated spirits of wine.

In making the solution the proportions are as follows: one hundred and sixty ounces (one English gallon) water, ten ounces best gelatine, ten ounces dextrine, two and one-half ounces borax, two drops of glycerine to each fluid ounce of the solution, and two and one-half ounces pure spirits of wine to the whole solution.

In making the solution the gelatine, borax and dextrine should be soaked in cold water (one hundred and sixty ounces) until the gelatine becomes soft and then the ingredients should be warmed up to a temperature of 180° Fahrenheit, when the gelatine, dextrine and borax will be dissolved, and when dissolved add to each fluid ounce of the solution two drops of glycerine and to the whole solution two and a half (2½) ounces pure spirits of wine. The solution should then be shaken or stirred up, so that all the ingredients may be thoroughly mixed. After this has

been done the solution should be strained to remove any undissolved particles, and then it will be fit for use.

At temperatures below 80° or 85° Fahrenheit the ingredients form a jelly, so that before they are fit for use they should be warmed to a temperature of 100° Fahrenheit.

This solution is well adapted for the preservation of eggs and for the preservation of fruits having smooth skins, and especially for the preservation of grapes.

All articles covered with the solution must be thoroughly dried before they are packed, and in respect to grapes, after being dipped in the solution, they should be absolutely dried in the sun or in a heated room and then placed in paper bags and packed in boxes with a non-absorbent material. After the grapes have been dipped it is desirable that they should be subjected to centrifugal action to prevent drops of the solution forming into nodules. It would be well to subject the dipped grapes to a warm blast, so that it may be certain that they shall be dry when they touch one another.

It is better to pack treated eggs small ends downward, so that their yolks may not be displaced.

The artificial skin resulting from the solution is quite transparent and remarkably tough and elastic. It will be useless to treat with the solution any other than newly-laid eggs and fruit free from the slightest bruise. Besides dip- [fol. 1016] ping in the solution or painting with a brush, a very rapid method of coating eggs or hard smooth fruit is by rubbing the solution on with the hands. A boy or girl can so treat two thousand eggs a day. Hams, bacon and cheese covered with cheese-cloth or other envelope should be dipped in the solution and thoroughly dried. Warm water will remove the coating.

Having fully described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. A compound for forming a preserving coating, skin or envelope consisting of water, a glutinous matter, borax, spirit and glycerine, in substantially the proportions herein specified.

2. A compound for forming a preserving coating, skin or envelope consisting of water, spirit, borax, gelatine, dextrine and glycerine in substantially the proportions stated.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

Augustus Morris, James Augustus Parker.

Witnesses: Alice Elizabeth Miller, W. H. Dawson.

[fol. 1017] DEFENDANT'S EXHIBIT No. 30

United States Patent Office

Adriaan Louis De Stürler, of Overveen, near Haarlem, Netherlands

Process of Preserving Fruits, &c.

Specification Forming Part of Letters Patent No. 694,301, Dated February 25, 1902. Application Filed August 15, 1900. Serial No. 26,987. (No specimens)

To all whom it may concern:

Be it known that I, Adriaan Louis de Stürler, chemist, a subject of the Queen of the Netherlands, residing at 262 Zylweg, Overveen, near Haarlem, in the Kingdom of the Netherlands, have invented certain new and useful Improvements Relating to the Preservation of Fruit, Vegetables, Meat, Eggs, and other Like Perishable Substances, of which the following is a specification.

This invention relates to the preservation of vegetables, fruit, meat, eggs, and other perishable substances, either for storage or transit.

Hitherto in the preservation of foods, particularly fruit or meat destined for transit, it has been usual to inclose them in wrappers or coverings, which in the case of meat consist of muslin, the foods being enveloped in this manner with the object of protecting them from the injurious effects of germs or bacteria contained in the air. This method has not, however, been found satisfactory or reliable, as the substances treated are often found unfit for human food or in an unmarketable condition after transit, this often causing serious loss.

The object of my invention is to treat foods externally in such manner that they shall be preserved for storage in transit for a much longer time than has hitherto generally been possible, and thus enable many kinds of foods, such as perishable fruits, to be transported long distances by sea or land and delivered in a perfectly fresh condition.

According to my invention the surface of the food or substance to be preserved is first treated with a sterilizing medium—such, for instance, as sulfurous acid, formic aldehyde, or boracic acid—by which the surface of the food or substance is both sterilized, and protected from the deleterious action of the germs contained in the air. The food or substance is then closely enveloped in a wrapper of paper, cotton cellulose, muslin, or similar material, which has also been sterilized by impregnation with the sulfulous acid, formic aldehyde, boracic acid, or other suitable solution. This wrapper must envelop the food or substance as closely as possible, so as to exclude air from the surface of the said food or substance. The food or substance inclosed in the wrapper is then coated with or inclosed in a covering of heavy hydrocarbon, such as paraffin or other mineral grease or wax or spermaceti. This hydrocarbon covering may be applied to all kinds of foods which are not too delicate for such treatment by rapidly dipping the food enveloped in the wrapper in a bath of the said hydrocarbon heated to a temperature of about 40° to 80° centigrade, the temperature varying according to the class of food it is required to preserve.

I claim—

1. The method of preserving food which consists in treating the surface of the food with a gaseous sterilizing agent, then closely enveloping the sterilized food in a paper cover so as to leave no space between the cover and food for the collection of gas or moisture, and then dipping the said cover containing the food into a bath of waxy hydrocarbon whereby the food is effectively sealed from the atmosphere and the hydrocarbon is prevented from coming into contact with the food, substantially as described.

2. The method of preserving food which consists in treating the surface of the food with formaldehyde gas, then

closely enveloping the food in a paper cover so as to leave no space between the surface of the food and the cover for the collection of moisture or gas, then dipping the paper cover containing the food into liquid paraffin-wax and permitting it to cool, whereby the sterilized food is sealed from the atmosphere and the paper cover prevents the flavor or smell of petroleum affecting the food, substantially as described.

3. The herein-described method of preserving foods, which consists of the following steps in the order named, first, sterilizing the surface of the food, then closely enveloping the sterilized food in a sterilized wrapper causing said wrapper to snugly embrace the food and exclude the air from between the food and wrapper and then inclosing said wrapper and food in a covering of heated heavy hydrocarbon substantially as described.

In testimony whereof I have hereunto set my hand, in presence of two subscribing witnesses, this 31st day of July, 1900.

Adriaan Louis de Stürler.

Witnesses: W. Edward Lake, Walter J. Skerten.

(Here follow drawings, side folios 1018 and 1019)

[fol. 1020] United States Patent Office

Thomas Jefferson Peters, of Peters, Florida

Apparatus for Preparing Fruit for Shipment

1,245,380. Specification of Letters Patent. Patented Nov. 6, 1917.

Application Filed July 14, 1916. Serial No. 109,408.

To all whom it may concern:

Be it known that I, Thomas J. Peters, a citizen of the United States, and a resident of Peters, in the county of Dade and State of Florida, have invented a new and Improved Apparatus for Preparing Fruit for Shipment, of which the following is a full, clear, and exact description.

1018

DEFENDANT'S EXHIBIT No. 31.

T. J. PETERS.

APPARATUS FOR PREPARING FRUIT FOR SHIPMENT.

APPLICATION FILED JULY 14, 1916.

1,245,380. Patented Nov. 6, 1917.

2 SHEETS—SHEET 1.

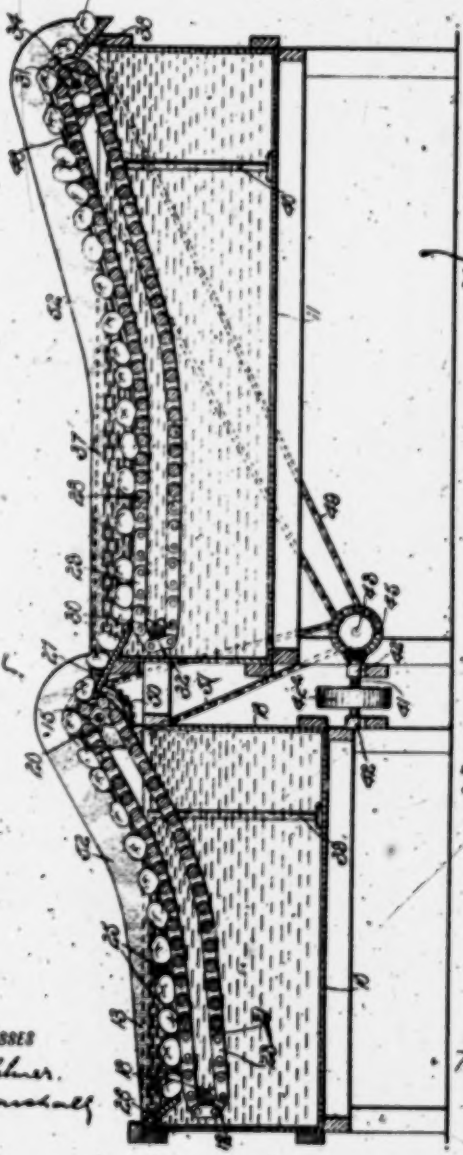


Fig. 1.

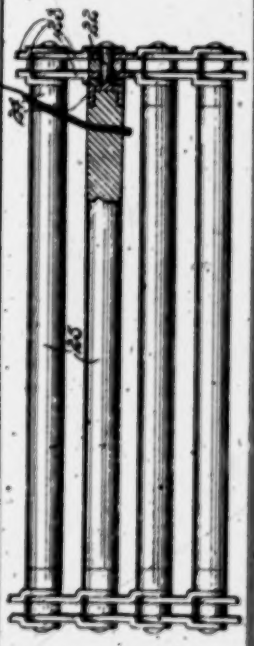


Fig. 2.

WITNESSES

Frank C. Palmer.

P. B. Marshall

INVENTOR

Thomas J. Peters

BY Munn & Co.

ATTORNEYS

1019

T. J. PETERS.

APPARATUS FOR PREPARING FRUIT FOR SHIPMENT.

APPLICATION FILED JULY 14, 1916.

1,245,380.

Patented Nov. 6, 1917.

2 SHEETS—SHEET 2.

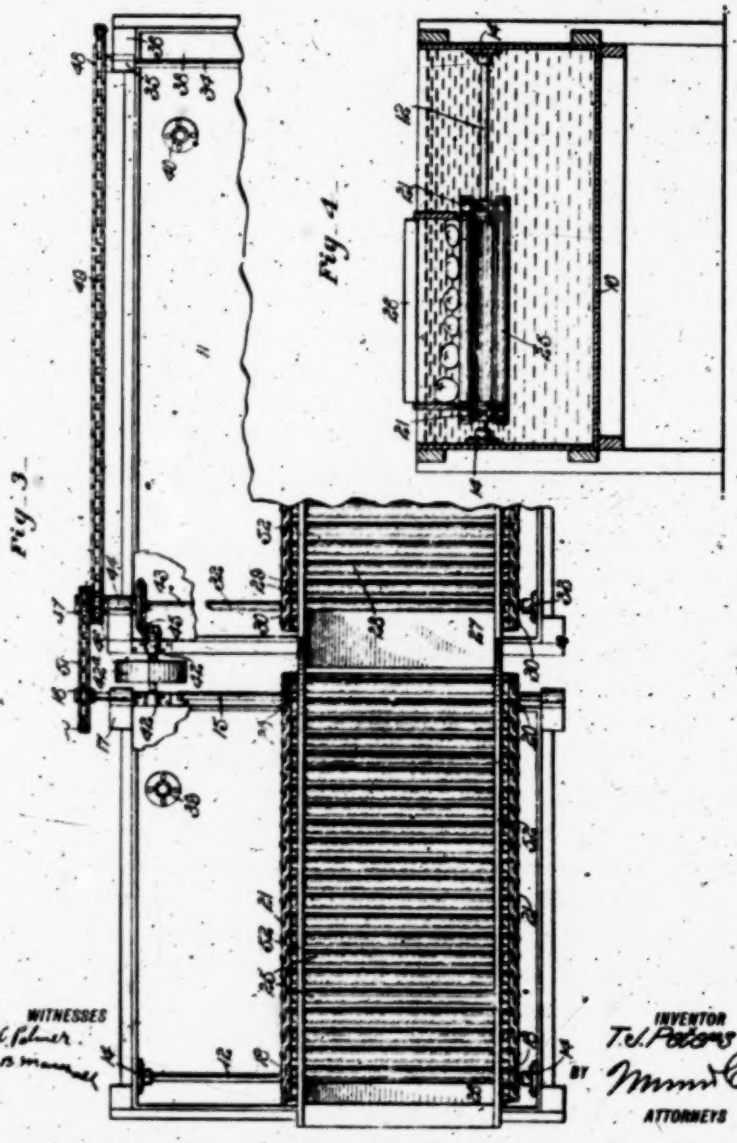


Fig. 3.

Fig. 4.

WITNESSES

T. C. Palmer.

J. B. Maxwell

INVENTOR

T. J. Peters

BY Munn & Co

ATTORNEYS

My invention has for its object to provide an apparatus for treatment to retard or hasten the ripening of tomatoes and other fruit, so that the tomatoes or fruit of the same maturity may be shipped for a short or long distance, to near or distant points, and arrive at each of the said points at substantially the same stage of maturity.

Another object of the invention is to wash the tomatoes or fruit, and treat them to destroy bacteria or fungus thereon, thereby preventing any rot or decay during shipment.

Additional objects of the invention will appear in the following specification, in which the preferred form of the invention is disclosed.

In the drawings similar reference characters denote similar parts in all the views, in which—

Figure 1 is a longitudinal sectional view of the apparatus used in carrying out my process:

Fig. 2 is an enlarged fragmentary view partially in section showing the manner of constructing the conveyor means;

Fig. 3 is a fragmentary plan view; and

Fig. 4 is a transverse sectional view of one of the tanks.

While my apparatus is especially well adapted to be used in the treatment of tomatoes, it will, of course, be understood that the apparatus may be used in treating other vegetables and fruit.

In the shipment of tomatoes, there has been great difficulty in the past in making the shipments in a manner which will assure the arrival of the tomatoes or fruit at the market matured to a point where the best price may be obtained. It will be understood that it is necessary to pick the tomatoes green for shipment, and that, not only is it impossible always to obtain the tomatoes at the same stage of maturity, but that the matter of the distance to the different markets introduces another factor which must receive the careful attention of the grower and shipper. While the tomatoes at a given stage of maturity may be shipped with safety to one market, to obtain the maximum price, the same fruit if shipped to another market which is a shorter or longer distance away, may be green or overripe on arrival, which would, of course, make it impossible to sell the tomatoes at the highest price. While it has been

necessary for all growers and shippers in the past to contend with these difficulties, they are removed by the use of my method and apparatus, which is set forth in detail in the specification, and in addition, my method includes treating the tomatoes to free them from disease when they are shipped, so that there will be no danger of rot or decay during shipment. To accomplish this, my method includes means to destroy bacteria, fungus, and other diseases which would otherwise develop in the fruit during the shipping period.

By referring to the drawings, it will be seen that in carrying out my method, I make use of two tanks 10 and 11, a shaft 12 being disposed transversely in the tank 10 below the normal fluid level 13, the shaft 12 being journaled in bearings 14 at the side of the tank. Another shaft 15 is journaled in bearings 16 in brackets 17 disposed above the end 18 of the tank. To each of these shafts 12 and 15 there is secured a set of sprocket wheels, one set of sprocket wheels 19 being mounted on the shaft 12 for rotating therewith, and the other set of sprocket wheels 20 being mounted on the shaft 15 for rotating therewith. Two companion sprocket chains 21 are provided, which are disposed around the sprocket wheels 19 and 20, thereby connecting the shafts 12 and 15. Pins 22 connect the links 23 of the sprocket chains 21, extending inwardly beyond the links 23 and being provided with bearings 24 in which transversely disposed rollers 25 are disposed. These rollers, together with the sprocket chains 21 serve as a conveyor means for moving the tomatoes through and out of the tank 10.

It will be seen by referring to Fig. 3 of the drawings, that there is a considerable space in the tank at one side of the said conveyer means, this space being provided so that when desired ice may be placed under the conveyer means, which will lower considerably the temperature of a washing fluid contained in the tank 10. The object in subjecting the tomatoes to an ice water bath is to retard the de- [fol. 1021] velopment of the fruit so that the maturity of the fruit will be considerably delayed, which treatment would be advisable if the tomatoes were to be shipped for a period of, say six days, while the tomatoes would mature during the shipment in the ordinary course in three days.

It will, therefore, be seen that by the use of my method the tomatoes of a certain maturity may be shipped to a predetermined market, and obtain the maximum price, which is now impossible by the methods of packing and shipment which are being followed by tomato growers and shippers. In some cases tomatoes are at such a stage of maturity that, if they were shipped for a certain period they would in the usual course arrive green, and this would prevent the shipper from obtaining the maximum price, for it would be necessary in such a case either to sell the tomatoes for consumption in this unripe state, or to hold them under proper conditions for ripening. In either case the cost to the consignee would be considerable, and this would naturally lessen the market value of the fruit on arrival. In such a case, where the tomatoes are unripe when the period of shipment is started, instead of using ice water in the tank 10, I fill the tank 10 with warm water, the temperature of which and the period during which the tomatoes are to remain in the said warm water being determined by the maturity of the fruit and the necessary shipping period.

The tomatoes are deposited in the tank 10 at a chute 26, the weight of the tomatoes serving to press the fruit beneath against the rollers 25, and with the rotation of the shaft 15 the rollers 25 serve to move the tomatoes through the washing bath in the tank 10, either cold or warm as occasion may require, and out of the tank 10 at the shaft 15, where the tomatoes are fed to a chute 27 which directs them into the tank 11.

In this tank 11, I make use of a fluid containing disease-destroying properties, which will kill fungus, bacteria, or other germs and matter which would, in the ordinary course, develop decay and rot in the tomatoes during their shipment. A solution of any desired fungicide may be used in this tank 11, having in mind the particular conditions at hand. In many cases a solution of Bordeaux mixture has been found to satisfy the requirements.

The tomatoes are deposited by the chute 27 on rollers 28 which are similar to the rollers 25, and which are mounted on links 29 of two sprocket chains which correspond with the sprocket chains 21, which have been described. These sprocket chains are disposed around sproket wheels 30 and 31, the sprocket wheels 30 being secured to a shaft 32 jour-

naled in bearings 33 at the sides of the tank 11, and the sprocket wheels 31 being secured to a shaft 34 journaled in bearings 35 on brackets 36 extending from the sides of the tank 11. The shaft 32 and the sprocket wheels 30 are disposed below the normal level 37 of the fluid in the tank 11, so that the tomatoes as they slide down the chute 27 will press each other below the level 37 in the tank 11, and against the rollers 28, the ortation of the shaft 34 serving to move the sprocket chains and the rollers 28 to convey the tomatoes through the fluid in the tank 11 and up out of the fluid, inasmuch as the shaft 34 and the sprocket wheels 31 are disposed above the level of the fluid. The tomatoes pass from the rollers 28 to a delivery chute 38. The tomatoes, after having passed from the delivery chute, are dried in any approved manner.

There is an overflow pipe 39 in the tank 10, and there is an overflow pipe 40 in the tank 11, these overflow pipes 39 and 40 being provided for a purpose readily understood.

The two conveyer means, one in each tank, which have been described, are driven by the following means: A shaft 41 is journaled in bearings 42, and a driving pulley 42^a is mounted on the said shaft 11. A shaft 43 is journaled in bearings 44 in the frame of the tank 11, and this shaft 43 is driven by the shaft 41, by means of bevel gears 45. There is secured to the shaft 43, two sprocket wheels 46 and 47, the sprocket wheel 46 being connected with a sprocket wheel 48 on the shaft 34 by means of a sprocket chain 49, and the sprocket wheel 47 being connected with a sprocket wheel 50 on the shaft 15 by means of a sprocket chain 51.

Guides 52 extend from the chute 26 to the delivery chute 38, these guides being disposed adjacent the upper portions of the rollers 25 and 28, and at the sides of the chute 27, thereby preventing the lateral displacement of the tomatoes during their passage through the apparatus.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In an apparatus for preparing fruit for shipment, a tank containing a fluid, a rotatably mounted wheel disposed in the tank below the fluid, a second wheel rotatably mounted on a horizontal axis, disposed above the level of the axis of the first wheel, and a belt having upwardly disposed members spaced apart for supporting fruit, the belt

being disposed around the wheels for moving the fruit through the fluid to a point where it may be automatically discharged.

2. In an apparatus for preparing fruit for shipment, two tanks one containing a washing fluid and the other a disease-destroying fluid, means to move fruit out of one tank and [fol. 1022] into the other tank, and means to move the fruit through the last mentioned tank.

3. In an apparatus for preparing fruit for shipment, a tank containing a washing fluid, a second tank containing a disease-destroying fluid, means for directing fruit from the top of the first tank to the second tank, conveying means for moving fruit from the first tank to the first means, and conveying means for moving the fruit out of the second tank.

4. In an apparatus for preparing fruit for shipment, a tank containing a washing fluid, a second tank containing a disease-destroying fluid, means for directing fruit from the top of the first tank to the second tank, a rotatably mounted wheel at the first tank adjacent the said means, another rotatably mounted wheel in the first tank spaced from the first wheel and disposed in the fluid, conveyer means disposed around the wheels, a rotatably mounted wheel in the second tank, a second rotatably mounted wheel at the second tank and disposed above the first wheel in the second tank, and conveyer means disposed around the last two mentioned wheels.

5. In an apparatus for preparing fruit for shipment, a tank containing a washing fluid, a second tank containing a disease-destroying fluid, means for directing fruit from the top of the first tank to the second tank, a rotatably mounted wheel at the first tank adjacent the said means, another rotatably mounted wheel in the first tank spaced from the first wheel and disposed in the fluid, conveyer means disposed around the wheels, a rotatably mounted wheel in the second tank, a second rotatably mounted wheel at the second tank and disposed above the first wheel in the second tank, conveyer means disposed around the last two mentioned wheels, and means for simultaneously rotating a wheel in each tank.

6. In an apparatus for preparing fruit for shipment, a tank, a second tank, means for directing fruit from the

top of the first tank to the second tank, conveyer means for moving fruit from the first tank to the first means, and conveying means for moving the fruit out of the second tank.

7. In an apparatus for preparing fruit for shipment, a tank, a rotatably mounted wheel disposed on a transverse axis in the tank, a second rotatably mounted wheel spaced from the first wheel and disposed on a transverse axis at the tank and above the horizontal plane of the first wheel, and conveyer means disposed around the roller and spaced from the side of the tank to permit of the introduction of a cake of ice under the conveyer means.

8. In an apparatus for preparing fruit for shipment, a tank containing a washing fluid, a second tank containing a disease-destroying fluid, means for directing fruit from the top of the first tank to the second tank, a conveyer belt for moving fruit from the first tank to the said means, and a second conveyer belt for moving the fruit out of the second tank.

9. In an apparatus for preparing fruit for shipment, a tank and a conveyer, means for moving fruit through and out of the tank, the conveyer means being spaced from one side of the tank to permit of the introduction of a cake of ice under the conveyer means.

Thomas Jefferson Peters.

[fol. 1023] DEFENDANT'S EXHIBIT No. 32.

United States Patent Office.

Rex De Ore McDill, of Riverview, Florida

Fruit Preservative and Process for Using Same.

1,400,086. Specification of Letters Patent.
Patented Dec. 13, 1921

No Drawing. Application Filed January 12, 1921
Serial No. 436,777

To all whom it may concern:

Be it known that I, Rex De Ore McDill, a citizen of the United States, and a resident of Riverview, Florida, have

invented a new and useful Fruit Preservation and Process for Using Same.

This invention is an improvement in preserving fruits and relates particularly to treating raw citrus fruit with a coating which is impervious to moisture emanating from within the fruit and air from without, thereby preventing shrinkage and arresting decay of the fruit.

A novelty of this invention is that a preservative coating is applied to the fruit, which, from the nature of its composition and the method used in applying same is found to be flexible, transparent, lacking in chemical affinity, bacteria proof, and harmless if eaten, and it is further found to be a more efficient and cheaper method than refrigeration which is now the ordinary method used.

It has been estimated by authorities in the trade that fully five per cent. of the citrus fruit crops decay in transit. This decay is caused by insects puncturing the fruit, thorn pricks, and rough handling which abrades the skin and allows entrance to bacteria and fungi. Nature has provided a protection against decay in citrus fruits by the thin layer of outer cells containing bacteria proof terpenes in the nature of essential oils, which serves well while the fruit is on the tree but is not proof against the abrasive methods used in cleansing it for market and in addition it volatilizes together with moisture from within the fruit causing it to shrink. Decay is further promoted by the use of paper wrappers which absorb moisture thus acting as a host for spores and bacteria which are present in the packing houses, boxes and cars.

In packing citrus fruit the general method as to wash the fruit by scrubbing with soap and water using rotary brushes. This washing process is necessary because all citrus fruit is covered with a film of dirt. I have found by a study of the packing house methods that during the scrubbing operation the skin of the fruit is slightly abraded and often-times rotten fruit is passed through with the good fruit, inoculating the fruit with rot fungi. I have found this to be especially true in the disease known as stem end rot or where the trees from which they were picked were affected with dieback.

There are, to my knowledge, no methods for preventing decay in use at the present time, except the packing and

shipping of the fruit under refrigeration, by the use of pre-cooling rooms in the packing houses and ventilated refrigerator cars. This method has proven to be only a temporary expedient as the rot producing fungi are only rendered slightly dormant and soon become active when normal atmospheric temperature is again reached.

I have found that by disinfecting or fumigating the fruit and completely coating same with a thin film of wax that the fruit will keep in a perfect state for four months or longer at atmospheric temperatures, and further that only in cases where it is very dirty or where only small quantities of fungi or insects are present is it necessary to disinfect or fumigate. My usual method in working my invention is as follows: The fruit is scrubbed by the same method as now in practice and the fruit then goes to a rinsing bath, which may contain a solution of formaldehyde if a disinfectant is used. It is then fumigated with cyanid gas if a fumigant is found to be needed. It is then dipped in a coating bath which is prepared as follows; paraffin is mixed and heated with petroleum in the proportion found most suitable for the flexibility and thickness of the coating desired, the proportion found most generally satisfactory being seventy parts paraffin and thirty parts petroleum; the paraffin mixture is then poured onto hot water slightly below the boiling point, using only enough paraffin to entirely cover the water. Fruit dipped in this bath comes out completely coated with a thin transparent film of the wax mixture. The petroleum has a property of rendering the paraffin transparent and makes a thinner film than if the plain paraffin were used. Where fruit is preserved by this method through the summer months without refrigeration a thick coating of the paraffin alone is found more than satisfactory due to the fact that the addition of the petro- [fol. 1024] leum reduces the melting point of the paraffin. This coating is so thin and such a small quantity, two ounces being used to one hundred pounds of fruit, that it is harmless if eaten and if the skin of the fruit is used for preserves or marmalades the coating may be removed by immersing the fruit in hot water.

Fruit preserved by my process retains its flavor much better than by refrigeration due to the full retention of the flavors by preventing the evaporation.

Beta-naphthol may be used instead of petroleum for mixing with the paraffin and serves equally as well but is found to be more expensive. Paraffin and a mixture of paraffin with its solvents was found more satisfactory for a coating for the following reasons, inert chemically being acted upon by few reagents, cheapness, unlimited quantities available, hardens rapidly, forms a transparent coating, does not dissolve the essential oils of the fruit thus retaining the color and flavor and is harmless if eaten, and easily removed in hot water.

I claim:

1. The process for preserving fruit in the raw state, consisting of washing the fruit and then applying a coating to the fruit by passing the fruit through a film of paraffin floating on hot water.

2. The process for preserving fruit in the raw state consisting in floating a film of paraffin on hot water and passing the fruit to be coated up under said floating film and lifting the same whereby an integral continuous coating will be applied to the fruit.

3. A preserved raw fruit having a covering envelop of paraffin formed by lifting a continuous integral sheet of paraffin by the fruit from the surface of hot water.

4. The process for preserving fruit in the raw state consisting in producing a film of paraffin wax on the surface of a liquid which is held at a heat to maintain the fluidity of the film and causing the fruit to enter said film to produce a coating thereon.

Rex De Ore McDill.

[fol. 1025] DEFENDANT'S EXHIBIT No. 33

A. D. 1869, 21st June. No. 1893

Preserving Animal and Vegetable Substances

Letters Patent to Martin Olsson, of No. 69, Richmond Road, Barnsbury, in the County of Middlesex, for the Invention of "Improvements in Preserving Animal and Vegetable Substances."—A communication from abroad by Henrik Gahn and Elof Esaias Edgvish, both of Upsala, in the Kingdom of Sweden

Sealed the 30th November 1869, and Dated the 21st June 1869

Provisional Specification left by the said Martin Olsson at the Office of the Commissioners of Patents, with his Petition, on the 21st June 1869

I, Martin Olsson, of No. 69, Richmond Road, Barnsbury, in the County of Middlesex, do hereby declare the nature of the said Invention for "Improvements in Preserving Animal and Vegetable Substances," to be as follows:

This Invention has for its object improvements in preserving animal and vegetable substances, and consists in employing boracic acid for this purpose.

[fol. 1026] In the case of meat the meat to be preserved may either be dipped into or sprinkled with a solution of the acid, or the acid in its crystalline state may be rubbed into it either alone or mixed with salt or other material.

For preserving meat for a considerable length of time I employ boracic acid together with salt. For 100 lbs. of boneless meat about 2½ lbs. of the acid mixed with about 2 lbs. of salt, should be carefully rubbed into the meat; the

meat should then be evenly and closely packed in a wooden cask, a portion of the mixture having first been strewn over the bottom of the cask and afterwards over each layer of the meat. A loose cover with a light weight upon it is then put upon the top of the meat and is left for from 3 to 4 days till sufficient brine is formed to well cover the meat; the loose cover is then removed and a thin layer of fat is poured over the brine to prevent the formation of mildew.

When the object is only to preserve meat for a short time the simplest plan is to dip it for 15 to 30 minutes in a pure solution of the acid, and afterwards to let it hang, when it will keep fresh for from 2 to 3 weeks.

Eggs dipped for a few minutes into a solution of boracic acid will keep fresh for a long time.

Perfectly sweet milk mixed with an extremely small quantity of a solution of boracic acid will also keep much longer than milk not mixed with it.

Vegetables also may be kept fresh for several weeks by soaking them for a time in a solution of boracic acid provided they are not subsequently allowed to dry up.

Boracic acid will also be of great service to brewers and wine merchants, as the formation of vinegar may be prevented by adding a small quantity of the acid to the beer or wine.

Fresh butter mixed with a small quantity of the acid will be prevented from turning sour or rancid.

[fol. 1027] Specification in pursuance of the Conditions of the Letters Patent Filed by the Said Martin Olsson in the Great Seal Patent Office on the 21st December, 1869

To all to whom these present shall come, I, Martin Olsson, of No. 69, Richmond Road, Barnsbury, in the County of Middlesex, send greeting:

Whereas, Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twenty-first day of June, in the year of our Lord One thousand eight hundred and sixty-nine, in the thirty-third year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me,

the said Martin Olsson, Her special licence that I, the said Martin Olsson, my executors, administrators, and assigns, or such others as I, the said Martin Olsson, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "Improvements in Preserving Animal and Vegetable Substances," a communication to him from abroad by Henrik Gahn and Elof Esaias Edgvish, both of Upsala, in the Kingdom of Sweden, upon the condition (amongst others) that I, the said Martin Olsson, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

Now know ye that I, the said Martin Olsson, do hereby declare the nature of the said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:

This Invention consists in using boracic acid for preserving food and like substances of animal or vegetable origin from, turning putrid, sour, or rancid.

[fol. 1028] This acid is without doubt one of the most powerful antiseptics hitherto discovered, and contrary to most other substances possessing similar qualities, it has the great advantage of being almost tasteless, absolutely free from smell, and not in any way injurious to health.

The chemical action of boracic acid when used for the above purpose consists in preventing or staying any process of fermentation caused by absorption of the oxygen of the air, but it does not materially, if at all, interfere with alcoholic fermentation or the formation of mildew; these processes being apparently dependent on other causes.

The acid can be applied for the purposes of preservation, first, alone in its dry crystalline form; secondly, in the same

way, but mixed with other dry or liquid substances; or, thirdly, dissolved in water or some other fluid, the general rule being to use the dry acid when a permanent, and the solution when only a temporary effect is required.

The acid used should be refined or chemically pure, not such as is generally sold and still less in the form of common borax. When the acid is used as a solution care must be taken to have the latter well saturated.

The best solution for ordinary purposes consists of the acid dissolved in water, one imperial gallon of the latter absorbing about 6½ ounces avoirdupois of the former at a temperature of 60 to 70 degrees Fahrenheit. As it however takes some days to dissolve the latter quantity without artificial heat, the melting process may be accellerated by using hot water, but it ought not to reach the boiling point, as in that case the strength of the acid is somewhat reduced by evaporation.

The articles that in particular may be preserved by the application of boracic acid are meat, game, and poultry, fish eggs, butter, vegetables, milk, and malt liquors.

I will proceed to give general directions for the treatment of each of these articles.

The processes which I describe are those which I prefer, but they can of course be modified without departing from my Invention.

For preserving meat for ordinary household purposes it is sufficient to soak a joint from 15 to 30 minutes in the above solution (6½ ozs. of acid to 1 gallon of water), after which it is hung up to dry, and will remain fresh for a fort- [fol. 1029] night or longer. If the meat need only be kept for a few days a simple dipping or thorough wetting of the joint is generally sufficient except in very hot or muggy weather when a repeated application of the solution is advisable.

When it is required to keep meat for any length of time, for instance, in order to import it from remote countries, or to provision ships for long voyages, the acid must be applied dry in the same way as salt, and used thus alone in sufficient quantity it effectually prevents putrefaction for almost any length of time. It has however a tendency gradually to dissolve the membranes forming glue, which in the course of a few weeks begins to affect the taste of

the meat unless some admixture is used for counteracting this effect. Of different substances that have been tried for that purpose pulverized salt or alum appear to be the most advantageous, a mixture of 1 lb. of the latter with 2 lb. of the acid, having in particular shewn satisfactory results; 3 lbs. of this mixture are sufficient to preserve 100 lbs. of meat, and it may be applied in the following manner:—The meat after being boned and cut into pieces of moderate size is placed in a cask or tub, the mixture being strewn on the bottom thereof, and also between each layer, and on the top of the meat; the meat is then covered with a loose lid and a weight about twice as heavy as the meat itself superimposed and left for a few days until sufficient brine has been formed to well cover the whole. The weight and the loose lid are then removed and the cask or tub closed up in the usual way, care being taken to have it well filled and made as tight as possible so as to prevent the formation of mildew. The latter may also be precluded by pouring melted tallow or fat over the meat.

Another mode of preserving meat for some length of time is to inject into the veins of an animal after it has been killed and flayed, but before it is cut up, a solution of boracic acid, either pure or mixed with alum or salt, and afterwards to soak the whole carcase in a similar solution. To make this method more effectual the carcase ought to be packed in such a manner as to exclude the access of the air as much as possible.

In preserving game and poultry. The treatment prescribed for meat may be applied in this case, care being taken to have the entrails drawn first, and the inside well wetted with the solution.

[fol. 1030] For preserving fish. When required to be kept only for two or three days, it should be gutted and then dipped (but not left immersed) once or twice in the solution, or occasionally sprinkled with the same. To preserve it for some time the dry acid may be, by preference, used mixed with alum and sugar in the proportion of 2 lbs. of acid to 1 lb. of alum and 2 lbs. of sugar.

Shell fish, as oysters and lobsters, may also be preserved, the former by being kept and the latter by being boiled in a solution of the acid.

For preserving eggs, they should be steeped in the solution for half an hour, they will remain fresh for some time, even if exposed to a high temperature.

Vegetables may be kept fresh for some days by being dipped in or sprinkled with the solution and not allowed to dry up before required for use.

Different kinds of perishable fruit, for instance, pine-apples, melons, etc., can likewise be kept a long time beyond the regular season by being packed in the dry acid.

Boracic acid is particularly adapted for preserving milk sweet, and can be used for this purpose either in its dry form or as a solution. In the former case ⅛ to ¼ oz. should be dissolved in a gallon of milk while it is still tepid, and in the latter one gill or two may be added to a gallon, the quantity depending of course on the state of the temperature and the length of time the milk is required to be kept.

In the preservation of malt liquors boracic possesses the property of preventing acetic but not alcoholic fermentation; it is of great value for brewers and distillers, and can be applied dry or in a liquid form, as with milk, and either in making the beer or spirits, or mixed with it afterwards according to circumstances.

Although the acid to some extent removes incipient decay or acidity no satisfactory result can be obtained unless the article to be preserved is perfectly fresh when it is applied.

Having thus described the nature of my said Invention, and the manner of performing the same, I would have it understood that what I claim is, the combining or treating meat, game, poltry, fish, eggs, butter, edible vegetables, milk, malt liquors, and such like animal and vegetable sub-[fol. 1031] stances with boracic acid, either alone or mixed with other substances, and thereby preserving such substances, as herein-before set forth.

In witness whereof, I, the said Martin Olsson, have hereunto set my hand and seal, this Twentieth day of December, in the year of our Lord One thousand eight hundred and sixty-nine.

Martin Olsson. (L. S.)

[fol. 1032] DEFENDANT'S EXHIBIT No. 34

A. D. 1880, 16th June. No. 2438

Preservation of Alimentary Substances

(This Invention Received Provisional Protection Only)

Provisional Specification Left by Thomas Foster Wilkins at the Office of the Commissioners of Patents on the 16th June, 1880

Thomas Foster Wilkins, of Lavender Road, Clapham Junction, London, in the County of Surrey

"An Improved Process for the Preservation of Alimentary Substances"

My Invention relates particularly to the preservation of shell fish and of eggs, but may be applied to the preservation of other articles of food.

My improved process consists essentially in first treating the article to be preserved with an antiseptic, and then coating it with a paraffin melting only at a very high temperature, and devoid of taste and smell.

I propose to immerse the article to be preserved in a solution of one or more of the following substances, that is to say, I may use any one of these substances alone or any combination of them:—They are, potassic Chloride, sodic chloride, boracic acid, glacial metaphosphoric acid, salicylic acid, salicin, biborate of soda, the alums, and sugar.

The period of immersion may vary from a few minutes to several hours, according to the nature of the article to be treated, and other requirements.

The article under treatment having been immersed in the antiseptic bath for such time as may have been found expedient, I propose to take it out of the solution and dip it in melted paraffin which must be of such quality as will melt only at a high temperature, and I now give preference to the use of what is known as "Young's" paraffin, the melting point of which is 128° "Fahrenheit."

After the paraffin has cooled and set upon the article, the dipping may be repeated until the article is sufficiently coated.

It being very desirable that every part of the article when submerged should be in contact with the paraffin, and that no part of the coating be removed in the operation of withdrawal from the bath of paraffin, I propose to sling the article with string, or to place it in any apparatus which I may find suitable for effecting my object.

[fol. 1033] DEFENDANT'S EXHIBIT No. 35

A. D. 1880, 25 November. No. 4910

Antiseptic for Preservation of Meat, &c.

Letters Patent to Gerard Wenzeslaus von Nawrocki, of the Firm of J. Brandt and G. W. von Nawrocki, Patent Agents, of No. 124, Leipziger Strasse, Berlin, in the German Empire, for an Invention of "An Improved Preparation of Antiseptic for the Preservation of Meat, Fish, and other Articles of Food."

A Communication by Otto Leupold, of Stuttgart, in the German Empire

Complete Specification Filed by the said Gerard Wenzeslaus von Nawrocki at the Office of the Commissioners of Patents on the 25th November, 1880

Gerard Wenzeslaus von Nawrocki, of the Firm of J. Brandt and G. W. von Nawrocki, Patent Agents, of No. 124, Leipziger Strasse, Berlin, in the German Empire

"An Improved Preparation of Antiseptic for the Preservation of Meat, Fish, and Other Articles of Food"

A Communication by Otto Leupold, of Stuttgart, in the German Empire

Borac acid is the most effectual antiseptic for the preservation of meat and other articles of food, but its application to such purposes in the pure state is impracticable on account of its more or less insoluble nature.

According to the present Invention a soluble compound of boracic acid is obtained by the admixture therewith of

borax, for which purpose the two substances are mixed together in water in the proportions of about one atom of borax to from 5 to 10 atoms of boracic acid. By this means a perfect solution and mixture is obtained with very little water, and which on evaporating gives a solid compound that is soluble in about ten parts of cold water, and that is applicable with very good effect in the dry state for preserving meat, fish, milk, butter, and other articles of food: Instead of borax an equivalent quantity of caustic soda or potash, or of their carbonates, can be used for rendering the boracic acid soluble.

The best proportions of the above compound have been found to be one atom of borax to six atoms of boracic acid, therefore 10 parts by weight of borax to 195 parts by weight of boracic acid. These are dissolved in at least from 250 to 300 parts of water, if the compound does not require to be filtered (which depends upon the purity of the raw materials used), or in from 1000 to 1500 parts of water if [fol. 1034] it has to be filtered. The compound is then evaporated until it has attained the consistency of syrup, whereupon it is allowed to cool, and is dried and ground to a powder.

Having thus described the nature of this Invention, and in what manner the same is to be performed, as communicated to me by my correspondent, I claim,—

First. The preparation of an antiseptic consisting of boracic acid rendered soluble by admixture of either borax, caustic soda, or potash, or carbonates of soda or potash, substantially as herein described.

Second. The use of the antiseptic referred to in the preceding claim for the preservation of meat, fish, butter, milk, and other articles of food.

In witness whereof, I, the said Gerard Wenzeslaus von Nawrocki, have hereunto set my hand and seal, this Twenty-second day of November, in the year of our Lord One thousand eight hundred and eighty.

Gerard Wenzeslaus von Nawrocki. (L.S.)

[fol. 1035] DEFENDANT'S EXHIBIT No. 36

A. D. 1881, 12th January. No. 140.

Preservation of Alimentary Substances, &c.

Letters Patent to Thomas Foster Wilkins, of Lavender Road, Clapham Junction, in the County of Surrey, Gentleman, for an Invention of "Improvements in the Preservation of Alimentary Substances, and in the Use of Compositions Therefor."

Provisional Specification Left by the said Thomas Foster Wilkins at the Office of the Commissioners of Patents on the 12th January, 1881

Thomas Foster Wilkins, of Lavender Road, Clapham Junction, in the County of Surrey, Gentleman

"Improvements in the Preservation of Alimentary Substances, and in the Use of Compositions Therefor"

My Invention relates to the preservation of various alimentary substances, such as meat, fish, shell-fish, eggs, and certain vegetables, by treating them, firstly, with an antiseptic or a combination of antiseptics, and then coating them with uncrystallized hydro-carbon; or, in some cases, by coating them with uncrystallized hydro-carbon without previous treatment with an antiseptic or antiseptics.

The mode of procedure may be as follows:—I propose to immerse the articles to be preserved in a solution of one or more of the following substances, namely:—Potassic chloride, sodic chloride, boracic acid, glacial metaphosphoric acid, alum, sugar, or the borates, biborates, silicates, acetates, and carbonates of the alkalis. From 2 grains to 30 grains should be used of metaphosphoric or orthophosphoric acid (I would mention that the former speedily becomes converted into the latter when kept in solution); from 3 grains to 45 grains of sugar; from 1 grain to 1 dram of any other of the said antiseptics.

Or, in lieu of placing the articles in the antiseptic bath, I may inject the solution by means of a "Carson's" instrument (which may be modified for that purpose as may be required), or using any suitable injector.

The article being sufficiently impregnated with the antiseptic solution, I propose to dip it into melted uncrystallized hydro-carbon, such as chrisma, cosmoline, vaseline, or preferably phylaxine; or I may in some cases find it expedient to use this coating without the previous antiseptic treatment.

After the article has been dipped into the uncrystallized hydro-carbon I may, when desirable, wrap the article in paper, vegetable parchment, muslin, or other suitable envelope previously brushed over with melted hydro-carbon.

[fol. 1036] Specification in Pursuance of the Conditions of the Letters Patent Filed by the said Thomas Foster Wilkins in the Great Seal Patent Office on the 6th July, 1881

Thomas Foster Wilkins, of Lavender Road, Clapham Junction, in the County of Surrey, Gentleman

"Improvements in the Preservation of Alimentary Substances and in the Use of Compositions Therefor"

My Invention relates to the preservation of various alimentary substances, such as meat, fish, shell fish, eggs, and certain vegetables, by treating them, firstly, with an antiseptic or a combination of antiseptics, and then coating them with uncrystallized hydro-carbon; or, in some cases, by coating them with uncrystallized hydro-carbon without previous treatment with an antiseptic or antiseptics.

The mode of procedure is as follows:—

I immerse the article to be preserved, whether an animal or a vegetable substance, in a solution of one or more antiseptics.

Or, in lieu of placing the articles in an antiseptic bath, I may inject the solution by means of a "Carson's" instrument (which may be modified for that purpose as may be required), or by using any suitable injector.

The strength of the antiseptic solution will necessarily vary with the nature of the article to be treated, and also with the mode of applying the solution. In using metaphosphoric or orthophosphoric acid I may employ from 2 grains to 30 grains of the acid; from 3 grains to 45 grains of sugar for every pound of the article to be preserved;

with other antiseptics, from one grain to one dram, and in solution or otherwise.

In the preservation of kippered fish I have found the following solution and treatment to answer well:—

I take one part of sodium biborate and mix with two parts of sugar.

For each pound of fish to be kippered I add from ½ dram to 4 drams of this mixture to the quantity of sodium of chloride usually employed for salting, whether it should be employed in the dry state or as brine.

The article being sufficiently impregnated with the antiseptic solution (which point of impregnation necessarily varies with the nature of the article treated), I dip it into melted uncrystallized hydro-carbon, such as chrisma, cosmoline, vaseline, or preferably phylaxine; or I may in some cases find it expedient to use this coating without the previous antiseptic treatment.

After the article has been dipped into the melted uncrystallized hydro-carbon I may, when desirable, wrap the article in paper, vegetable parchment, muslin, or other suitable envelope previously brushed over with melted hydro-carbon.

I would have it understood that in mentioning sodium biborate and sugar as suitable for preserving kippered fish, I do not propose to confine myself to the use of those antiseptics, but to use any antiseptics or combinaton of antiseptics which I may find suitable for my purposes; also that I do not claim the use of the antiseptic treatment "per se," as I am aware that the antiseptics I have mentioned and others have already been used for the purpose of preserving alimentary substances.

I would also have it clearly understood that I do not propose to use a coating of any kind of hydro carbon but simply of such as is uncrystallized.

Having now described and ascertained the nature of my said Invention, and in what manner the same is or may be performed,—

I claim as secured to me by the hereinbefore in part recited Letters Patent,—

Firstly. The process of preserving alimentary substances by first treating them with an antiseptic or antisep- [fol. 1037] tics, and afterwards coating them with uncrystallized hydro-carbon, substantially as described.

Secondly. The use of uncrystallized hydro-carbon as a coating for preserving alimentary substances, substantially as described.

In witness whereof, I, the said Thomas Foster Wilkins, have hereunto set my hand and seal, this Fifth day of July, in the year of our Lord One thousand eight hundred and eighty one.

Thomas Foster Wilkins. (L.S.)

[fol. 1038] DEFENDANT'S EXHIBIT No. 37

A.D. 1881, 25th March. No. 1332

Compound for Preserving Organic Substances

Letters Patent to Frederick Settle Barff, of Kilburn, in the County of Middlesex, Professor of Chemistry, for an Invention of "A New Compound to be Employed in the Preservation of Organic Substances"

Provisional Specification Left by the said Frederick Settle Barff at the Office of the Commissioners of Patents on the 25th March, 1881

Frederick Settle Barff, of Kilburn, in the County of Middlesex, Professor of Chemistry

"A New Compound to be Employed in the Preservation of of Organic Substances"

This Invention relates to the preparation of a new material or chemical compound to be used for the preservation of organic substances.

In carrying out my Invention I take boracic acid and dissolve it in glycerine by the aid of heat, maintaining the temperature for four or five hours, taking care however that the temperature shall not be so excessive as to decompose the glycerine, and I add additional boracic acid from time to time until the boracic acid ceases to be dissolved, and the resulting compound is solid boroglycerine, which is a new chemical compound.

This compound can be dissolved quickly in hot water and slowly in cold water, and the resulting solution may be applied to the preservation of all organic substances either animal or vegetable.

Specification in Pursuance of the Conditions of the Letters Patent Filed by the said Frederick Settle Barff in the Great Seal Patent Office on the 9th September, 1881

Frederick Settle Barff, of Kilburn, in the County of Middlesex, Professor of Chemistry

"A New Compound to be Employed in the Preservation of Organic Substances"

My said Invention relates to the preparation of a new material or chemical compound to be employed for the preservation of organic substances.

[fol. 1039] For this purpose I take boracic acid and dissolve it in glycerine by the aid of heat, maintaining the temperature for about four or five hours, or until the desired combination is effected, care being taken however that the temperature employed shall not be so excessive as to decompose the glycerine; and I add to such solution or compound a further quantity of boracic acid from time to time until the boracic acid ceases to be dissolved. The compound resulting when allowed to cool is solid, and is what I have called boroglyceride, which is a new chemical compound.

As an example of the manner in which my said Invention may be effectively carried out, I proceed as follows:—

I heat glycerine to near its boiling point, and add boracic acid until it ceases to be dissolved, the proportions being about 92 parts by weight of glycerine to 62 parts by weight of boracic acid (crystallized), which is equivalent to 3 molecules of glycerine $C_3 H_8 O_3$ to one of boric oxide $B_2 O_3$. I maintain the mixture at a temperature of about 200° centigrade as long as water is given off. When the mass cools it becomes a yellowish transparent glacial substance tough and deliquescent; this dissolves in water, but when boiled in large quantities of the same it is decomposed into glycerine and boracic acid.

This before mentioned compound is also soluble in alcohol, and the solution has the property of preventing the

putrefaction of organic substances. The composition of the glacial body as determined by analysis is nearly $C_3 H_5 BO_3$, or $H_3 BO_3$, in which H_3 is replaced by the trevalent radicle BO_3. By using the constituents in different proportions different (substitution) products are formed, but the one mentioned is that which I prefer to use.

In order to employ the compound consisting of boracic acid and glycerine, I prepare a solution of the same either in water, alcohol, or other suitable solvent, and I either immerse in or impregnate with such solutions the organic substances to be operated upon.

Solutions may be prepared of various degrees of strength, but I have found that a solution consisting of about one part by weight of the compound before referred to and forty parts by weight of water will give good results, but other proportions may be adopted.

Solutions of the compound hereinbefore described may be applied to the preservation of all organic substances either animal or vegetable.

Having now described and particularly ascertained the nature of my said Invention, and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that what I consider to be novel and original, and therefore claim as the Invention secured to me by the hereinbefore in part recited Letters Patent is,—

The employment and use of the compound of boracic acid and glycerine herein referred to for and in the preservation of organic substances.

In witness whereof, I, the said Frederick Settle Barff, have to this my Specification set my hand and seal, this Nineteenth day of July, One thousand eight hundred and eighty one.

Fred^{k}, S. Barff. (L. S.)

[fol. 1040] DEFENDANT'S EXHIBIT No. 38

A. D. 1881, 2nd September. No. 3823

Preserving and Transporting Eggs

(This Invention Received Provisional Protection Only)

Provisional Specification Left by Jasper Wetter at the Office of the Commissioners of Patents on the 2nd September, 1881

A Communication from Abroad by Antoine Cruveiller, of Paris, France

Jasper Wetter, of New Wadsworth, Surrey

"Improvements in the Means of Preserving and Transporting Eggs"

A Communication from Abroad by Antoine Cruveiller, Paris, France

This Invention relates to the means of preserving and transporting eggs on a large scale.

The process applied for this purpose has the object, first, of destroying or neutralizing the minute organic germs which have penetrated through the shell, and tend to produce putrefaction; and second, in preventing the further intrusion of organic germs from the surrounding air. The first object may be attained by treating the eggs with a solution consisting of approximately 100 parts of pure boracic acid and 3 parts of distilled water. This solution is prepared at a moderate heat and must be applied cold.

The second object is attained by coating the eggs with a mixture of approximately 100 parts of potassium silicate, 100 parts of distilled water, and 10 parts of chalk. This coating closes hermetically the pores of the eggs and protects them against the surrounding air.

For drying the eggs after having been steeped in the solutions every egg is placed upright on a stand consisting of three short vertical tubes which form a regular triangle, and are sufficiently apart to hold the egg a little below its greatest circumference when placed between the tubes.

The tubes stand on a horizontal board, and are secured by iron pins or nails driven with their lower ends into the board and forming a core for each tube, the latter reaching

over the top of the nail so as to prevent a contact of the egg with the metal.

Every board carries a considerable number of eggs (preferably 100, supported by 300 tubes), and two, three, or more boards are arranged one over the other at suitable distances by means of stands or trestles.

For preparing the solutions a hemispherical metallic vessel is used, provided with a stirrer which consists of a vertical shaft provided with perforated wings, preferably three in number, said shaft being set in revolution by means of bevel wheels, a horizontal shaft, and a crank.

[fol. 1041] When prepared by the process described, the eggs are packed for preservation or transport by placing each egg in a paper bag and arranging the latter in a chest by means of a system of strings stretched across the chest, there being a string between any two adjacent series of bags for holding them apart, and one below the bags for supporting the latter, so that several layers of eggs can be stored one over the other; and as the strings supporting one layer pass over the bags of the nearest layer below it, the eggs are prevented from falling out when the chest is upset.

[fol. 1042] DEFENDANT'S EXHIBIT No. 39

A. D. 1882, 23rd December. No. 6134

Preservation of Animal and Vegetable Matter

Letters Patent to Joseph Townsend, of Glasgow, in the County of Lanark, North Britain, Manufacturing Chemist, for an Invention of "Improvements in and Relating to the Preservation of Animal and Vegetable Matter."

Provisional Specification Left by the said Joseph Townsend at the Office of the Commissioners of Patents on the 23rd December, 1882

Joseph Townsend, of Glasgow, in the County of Lanark, North Britain, Manufacturing Chemist

"Improvements in and Relating to the Preservation of Animal and Vegetable Matter"

This Invention has for its object the manufacture and application of improved compounds or mixtures for preserving animal and vegetable matter.

One improved preservative compound is formed by mixing or combining boracic acid and potash, suitable proportions being 100 parts by weight of crystallised boracic acid and 15 parts of caustic potash or 18½ parts of carbonate of potash.

A second improved preservative compound is formed by mixing or combining 100 parts of crystallised boracic acid, 14¼ parts of carbonate of soda and 20 parts of chloride of potassium.

A third improved preservative compound is formed by mixing or combining 100 parts of crystallised boracic acid, 77 parts of borax, and 30 parts of chloride of potassium.

The proportions named are preferred but may be varied within moderate limits. The ingredients are by preference combined or mixed by grinding or in a finely ground state.

For preserving fowls, beef, mutton, lamb, veal, fish, or other meat the powder can be dredged or dusted over the external surface, or the powder or mixture of ingredients can be dissolved and be applied by dipping the meat in the solution. Eggs are by preference steeped in the solution. For preserving milk and cream ¼ ounce of the powder is to be dissolved in each gallon. For preserving butter ¼ ounce of the powder is to be worked into every seven pounds [fol. 1043] of the butter after it has been cleansed. For preserving vegetable matter the compound or mixture may be applied either in solution or in the powdered form.

In some cases in preserving meat, the meat is by preference subjected to the action of a vacuum so as to exhaust air from internal parts, and a solution of the preservative compound is then allowed to penetrate with any suitable pressure. In other cases the meat is enclosed in cotton or other suitable cloth which is saturated with the preservative solution or has the powder dusted over it.

In one improved mode of preserving eggs, and applicable to other animal or vegetable matter, sawdust, or cotton wool, or other suitable absorbent, is saturated with the preservative solution and dried, and the eggs or other articles are packed with the prepared sawdust or other material or are placed in or covered by it.

When the preservative powder is used as an external application in cases where it is likely to become very dry or to

become detached a small proportion of chloride of magnesium is combined with it. This ingredient not only keeps the powder sufficiently damp but also promotes its preservative action.

[fol. 1044] Specification in Pursuance of the Conditions of the Letters Patent Filed by the said Joseph Townsend in the Great Seal Patent Office on the 22nd June, 1883

Joseph Townsend, of Glasgow, in the County of Lanark, North Britain, Manufacturing Chemist

"Improvements in and Relating to the Preservation of Animal and Vegetable Matter"

My said Invention has for its object the manufacture and application of improved compounds or mixtures for preserving animal and vegetable matter.

One of my improved preservative compounds is formed by mixing or combining boracic acid and potash, suitable proportions being 100 parts by weight of crystallised boracic acid, and 15 parts of caustic potash or 18½ parts of carbonate of potash.

A second of my improved preservative compounds is formed by mixing or combining 100 parts of crystallised boracic acid, 14¼ parts of carbonate of soda and 20 parts of chloride of potassium.

A third of my improved preservative compounds is formed by mixing or combining 100 parts of crystallised boracic acid, 77 parts of borax, and 30 parts of chloride of potassium.

The proportions named are what I prefer but may be varied within reasonable limits. The ingredients are by preference combined or mixed by grinding or in a finely ground state.

For preserving fowls, beef, mutton, lamb, veal, fish or other meat the powder can be dredged or dusted over the external surface, or the powder or mixture of ingredients can be dissolved and be applied by dipping the meat in the solution.

Eggs are by preference steeped in the solution. For preserving milk and cream the powder is by preference dissolved in a small quantity of water and the solution is thoroughly mixed with the milk or cream ¼ ounce of the powder

being used for each gallon. For preserving butter ¼ ounce of the powder is to be worked into every seven pounds of the butter after it has been cleansed. For preserving vegetable matter the compound or mixture may be applied either in solution or in the powdered form.

In some cases in preserving meat, the meat is by preference subjected to the action of a vacuum or partial vacuum so as to exhaust air from internal parts, and a solution of the preservative compound having been admitted into the vessel penetrates into the meat, atmospheric pressure or any suitable pressure being employed. In other cases the meat is enclosed in cotton or other suitable cloth whish is saturated with the preservative solution or has the powder dusted over it.

In one improved mode of preserving eggs, and applicable to other animal or vegetable matter, sawdust, or cotton wool, or carbonaceous matter, or other suitable absorbent, is saturated with the preservative solution and more or less dried, and the eggs or other articles are packed with the prepared sawdust or carbonaceous matter or other material or are placed in or covered by it.

When the preservative powder is used as an external application in cases where it is likely to become very dry or to become detached a small proportion of chloride of magnesium or chloride of calcium is combined with it. This ingredient not only keeps the powder sufficiently damp but also promotes its preservative action.

Having thus particularly described by said Invention and the manner of performing the same, I have to state that I do not destrict myself to the precise details hereinbefore de- [fol. 1045] scribed but that what I believe to be novel and original and claim as the Invention secured to me by and in terms of the hereinbefore in part recited Letters Patent is

1. The preservation of animal and vegetable matters by treating them with a mixture or combination of boracic acid and potash, substantially as hereinbefore described.

2. The preservation of animal and vegetable matters by treating them with a mixture or combination of boracic acid, carbonate of soda, and chloride of potassium substantially as hereinbefore described.

3. The preservation of animal and vegetable matters by treating them with a mixture or combination of boracic acid,

borax, and chloride of potassium substantially as hereinbefore described.

4. The application of any of the preservative compounds by dredging or dusting it in the form of powder upon the external surface of meat, as hereinbefore described.

5. The application of any of the preservative compounds by dissolving it and dipping the meat into the solution with or without the previous treatment by a vacuum to exhaust the air as hereinbefore described.

6. The application of any of the preservative compounds to milk, cream, and butter, by mixing the powder or a solution of it therewith as hereinbefore described.

7. The preparation of sawdust, cotton wool, carbonaceous matter or other suitable absorbent with a solution of any of the preservative compounds; and the packing or covering of eggs or other animal or vegetable matter with the prepared absorbent material as hereinbefore described.

8. The combination of chloride of magnesium or chloride of calcium with any of the preservative compounds when to be used in circumstances in which it is liable to become too dry as hereinbefore described.

In witness whereof I, the said Joseph Townsend, hae hereunto set my hand and seal this eleventh day of June in the year of our Lord One thousand eight hundred and eighty-three.

Joseph Townsend (L.S.)

[fol. 1046] DEFENDANT'S EXHIBIT No. 40

Date of Application, 5th Jan., 1888. Specification Accepted 10th Feb., 1888

A. D. 1888, 5th January. No. 214

Complete Specification

A New and Improved Method for the Preservation of Fresh Fruit for Storing or Transport and the Process of Preparing Packing Material for Such Purpose.

I, John Storer, of Number 5 Billeter Avenue London England but now temporarily of Clarence Street Sydney in the

Colony of New South Wales Professional Chemist do hereby declare the nature of my invention for A New and Improved Method for the Preservation of Fresh Fruit, for Storing or Transport, and the Process of Preparing Packing Material for such Purpose, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

My invention has for its object the preparation of packing material for the preservation in a cheap and convenient manner of all kinds of fresh fruits, for the storing and for the transport thereof to near or distant markets; and the prevention for a reasonable time of decay or damage therein.

The storing of fresh fruits for a reasonable time, and the transport thereof to distant markets, and often to near markets, require means which are not attained by the ordinary methods of packing, to prevent the natural decay of the fruit which is accelerated according to the greater quantity of moisture the fruit contains.

My invention consists in the preparation of the ordinary materials used for the packing of fruit, such as sawdust, chaff, grain husks, fine shavings, or other similar or convenient substances, or of paper, with a solution of Boracic Acid, or of Alkaline Borates, or Bi-borates, thereby applying to the desired object the antiseptic qualities of compounds of Boran, and their solutions, the same being non-poisonous and not injurious to human use in their application for antiseptic purposes.

I carry out my said invention by dissolving crystallised Boracic Acid, or an Alkaline Borate, or Bi-borate in water. Any one of these may be used with advantage, but the same may be usefully varied in practice according to the nature of the fruit, and having regard to the season in which the same is grown. Fruit not containing much moisture, or grown in a dry season, would not require the application of a material so strongly antiseptic as fruit contaning much moisture, or grown in a wet season. If the quality of the fruit or the season in which the same is grown, should, having regard to such considerations, require the application of a material of increased strength the stronger preparation [fol. 1047] may be used, or the preparations mentioned mixed together in desired proportions to vary the strength of the antiseptic material. I have found in practice that

Boracic Acid is the most convenient, most economical and efficient compound in its use and operation for general use for the purposes of my invention.

The quantity of water in which the substance or substances used should be dissolved may also be varied according to the above circumstances, so as to increase or lessen the antiseptic character of the solution. I have found in practice that the proportion of one pound avoirdupois of the chemical to one gallon of water furnishes a solution which is effective in general use.

The material used for packing, such as sawdust, chaff, grain-husks, fine shavings, or other similar material, is thoroughly saturated with the solution prepared as before mentioned, and mixed until the solution is thoroughly incorporated with the material. I have found for sawdust that the proportions of one gallon of the solution to one hundredweight of the material generally suffices. The wet material is then dried in a closed vessel by means of steam heat by any convenient method, until the whole mass is brought to a temperature throughout of at least 212 degrees Fahrenheit. The material is then thoroughly dried by any convenient method, when the same is ready for use.

If the fruits to be packed are of a bulky character, such for instance as apples, pears, oranges, lemons, limes, passion fruit, and so forth, the same are selected according to size by any of the convenient and known method, and are packed in the prepared material. The packing should be carried out in cases, preferably of the kind known as close cases. A thin layer of the prepared material should be placed in the bottom of the case. A layer of fruit being placed thereon, the spaces are filled up with the material, and the fruit covered with a layer thereof. Further layers of the fruit are then packed in the same way until the case is filled.

When it is desirable to afford an additional protection against decay, each fruit may be wrapped separately in tissue paper prepared by being saturated with the solution, and then dried, by any convenient methods. The fruit thus protected may be packed in cases by itself, or in material prepared as and in the manner before described.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:

1. The process of rendering packing material such as sawdust, chaff, grain husks, shavings, et cet-ra, antiseptic for the preservation of fresh fruit substantially as described, and for the purposes set forth.

2. The process of rendering paper antiseptic for the preservation of fresh fruit, substantially as described and for the purposes set forth.

3. The method of preserving fresh fruit by the packing thereof in antiseptic material, substantially as described and for the purposes set forth.

Dated this Seventeenth day of November 1887.

John Storer. Haseltine, Lake & Co., 45, Southampton Buildings, London, W. C., Agents for the Applicant.

Witness: Henry Higham, Clerk to Mr. A. De Lissa, Solicitor, Sydney.

[fol. 1048] DEFENDANT'S EXHIBIT No. 41

N° 9145 **A.D. 1893**

Date of Application, 8th May, 1893. Accepted, 1st July, 1893

Complete Specification

Improvements in the Method of and Means for Preserving Articles of Food

I, Ludwig Häusler of 6 Gr. Burstah, Hamburg in the German Empire, Manufacturer, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention relates to a new or improved method of and means for preserving articles of food, such as poultry fish meat fruit and vegetables, and consists in immersing

the articles in or surrounding them with an antiseptic mixture prepared especially for the purpose as hereinafter described and having for its essential constituents, glycerine boracic acid and gelatine.

In the preparation of the preservative mixture, I heat glycerine strongly so as to deprive it of all contained water, and during the heating, I add boracic acid until the glycerine is saturated. The mixture is kept at a temperature of about 200 degrees C. until nothing more evaporates. After the mixture has been allowed to perfectly cool itself, from 20 to 40 parts of water are added, and the mixture is placed in a water bath, more glycerine being added, the quantity of added glycerine being determined by the consistency desired for the product, and the mixture is kept at a temperature of about 60 degrees C. for about 24 hours, and finally allowed to cool. The product is a jelly-like transparent and translucent substance which in the cold condition resembles ice.

This substance, which for convenience I will call "Boroglycerine," when mixed with or dissolved in from one to twenty parts of hot water, forms the antiseptic part of my improved mixture. The proportions of the boroglycerine and water must be determined in each case by the conditions surrounding it, as for example, the temperature to which it will be exposed, the nature of the articles to be preserved, and the time during which they are to be kept.

The mixture itself is prepared by immersing from one half to an equal weight (more or less according to the thickness or consistency of the product desired), of gelatine in the boroglycerine solution for from 24 to 30 hours and then placing the solution with the glycerine therein on a water bath until the gelatine is dissolved. The solution is then allowed to cool down a little, but before it enters the jelly-like condition, the articles to be preserved are immersed coated or surrounded by it so that they will be completely covered by the cooled substance.

By this means the articles are entirely isolated from atmospheric influences and are fully and completely protected by the antiseptic.

The mixture itself is perfectly colourless, free from smell and innoxious.

When the articles preserved as hereinbefore described are required to be sent to some distance, they may be packed in tins or other perfectly airtight suitable vessels.

When the articles are required for use, they are removed from their packages (if packed), and are washed with luke-warm water. The mixture removed by this washing may be concentrated on the water bath and be used again if desired.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. The hereinbefore described method for preserving articles of food which consists in immersing them in or coating or surrounding them with a mixture of glycerine boracic acid gelatine and water prepared substantially as set forth.

[fol. 1049] 2. A mixture for preserving articles of food, consisting essentially of boro-glycerine water and gelatine, prepared substantially as hereinbefore described.

Dated this 6th day of May A. D. 1893.

William E. Heys, Agent for the Applicant.

[fol. 1050] DEFENDANT'S EXHIBIT No. 42

No. 25512. A. D. 1906

Date of Application, 12th Nov., 1906. Complete Specification Left, 13th May, 1907. Accepted, 7th Nov., 1907

Provisional Specification

Improvements in Fruit Treatment for Preservative Purposes

I, Edmund Harvey, of J. Travers and Sons, Ltd., of 119 Cannon Street, in the City of London, Fruit Buyer, do hereby declare the nature of this invention to be as follows:

This invention relates to improvements in fruit treatment for preservation purposes, particularly so called "dried fruits" or partially dried fruits.

Foreign fruits intended for the dried fruit trade in this country, for example, are, as well understood, usually subjected, prior to export, to a sun or other drying process and it may be also to a further "curing" process, the so treated fruits being respectively known as "sun-dried" or "single cured" fruit or as "double-cured fruit." It not infrequently occurs however that the fruit degenerates owing to injurious climatic effects or for other reasons, as for instance injurious fermentation, and requires further treatment such treatment being termed "recuring."

Now this invention has for object by improved treatment or "recuring" to destroy or remove from fruit, deleterious substances, whether resulting from fermentation or the like, or otherwise, and to improve the keeping quality of the fruit as by preventing, arresting or minimising, fermentation or other injurious effects or for one or more of these purposes.

For the treatment of "double cured" plums, placed or contained in a perforated or other receptable whereby liquor can obtain free access to the fruit, the plums are, according to this invention, immersed for a short period in a boiling, or practically boiling, solution of weak alkali, then dried by artificial heat and again similarly immersed in boiling, or practically boiling, water that contains in solution small quantities of soda and boracic acid, sulphurous acid or other non-injurious antiseptic after which, the plums, either in a loose or packed condition according to requirement, are again subjected to the action of heat.

In certain cases as for example when the fruit is in fairly good condition it may suffice to immerse it in the boiling or practically boiling solution of soda and antiseptic, and subsequently submit it to the action of heat though the complete process as above set forth is usually necessary.

According to one example of the treatment of "double cured plums" according to this invention the fruit contained in a cage or basket is immersed for half a minute or more in a boiling solution of crystalline sodium carbonate in the proportions of about twenty pounds of the said carbonate to one hundred gallons of water, after which the fruit distributed in single layers on trays is subjected in an

oven for say thirty minutes or thereabouts to a temperature of from ninety degrees Fahrenheit to one hundred and twenty degrees Fahrenheit, or until sufficiently dry and dark in colour, and then, with or without previous cooling the fruit, contained in a cage or basket, is immersed for one minute or thereabouts in a boiling solution formed by dissolving about twenty pounds of crystalline sodium carbonate and about eight pounds of a solution of commercial sulphurous acid say of 1035 specific gravity in about one hundred gallons of water. The plums after removal from [fol. 1051] the solution are packed, whilst hot, in boxes and in this state heated for from about thirty minutes to two hours in an oven that is at a temperature of from one hundred degrees Fahrenheit to one hundred and twenty degrees Fahrenheit or thereabouts.

The details of procedure may be more or less varied according to the quality of the particular fruit to be treated. For examples, in fruit of comparatively good condition the proportion of soda in the weak alkali solution may be somewhat reduced with advantage or in some cases a rather weak alkali solution may be caused to answer the purpose by somewhat increasing the period of immersion. Moreover instead of drying the fruit between the above described immersion treatments merely by placing the same in an oven, currents of hot air may be circulated as by fans, amongst and around the fruit.

Sometimes also instead of the final heating being effected whilst the fruit is in boxes or cases in which it has been packed whilst hot, the plums may, in a loose state, be dried by heat and immediately packed hot.

For the treatment of "single cured" or sun-dried plums the fruit if in good condition may be immersed in the weak alkali solution as in the case of the "cured" plums and then packed whilst hot, and subjected to further heat treatment as described with reference to "double cured plums" after the immersion of such "double cured plums" in the second of the two above mentioned solutions.

In the case of "single cured" plums that are before treatment in comparatively poor condition these may advantageously be treated in all respects as described with reference to "double cured" plums.

Valencias and sultanas are treated according to this invention by subjecting them with or without previous treat-

ment by immersion in the weak alkali solution as described in reference to plums or in a weak solution of sodium chloride with a solution or mixture comprising cream of tartar, sodium chloride, starch or starchy matter and water, convenient proportions being say 3 lbs. cream of tartar, 2 lbs. sodium chloride, 1 lb. starchy matter in the form of arrowroot and 10 gallons of water.

The basket or vessel containing the fruit should be kept in motion during treatment which should be maintained for say half a minute or more, or until any surface sugar crystallization has been removed and internal crystals fused or dissolved after which the fruit arranged in thin layers is subjected in an oven or in any other suitable manner for say from two to four hours to a temperature of from say 120° F. to 150° F.

Although various details as to temperatures and periods of treatment and the like have been given by way of examples for fruit treatment according to this invention I desire it to be understood that I do not limit myself thereto but that the same may be more or less varied without departing from this invention.

Dated this 12th day of November, 1906.

For the Applicant, W. Lloyd Wise, 46 Lincoln's Inn Fields, London, W.C., Chartered Patent Agent.

Complete Specification

Improvements in Fruit Treatment for Preservative Purposes

I, Edmund Harvey, of J. Travers and Sons, Ltd., of 119 Cannon Street, in the City of London, Fruit Buyer, do [fol. 1052] hereby declare the nature of this invention, and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

This invention relates to improvements in fruit treatment for preservation purposes, particularly so called "dried fruits" or partially dried fruits.

Foreign fruits intended for the dried fruit trade in this country, for example, are, as well understood, usually subjected, prior to export, to a sun or other drying process and it may be also to a further "curing" process, the so treated fruits being respectively known as "sun dried" or

"single cured" fruit or as "double cured fruit." It not infrequently occurs however that the fruit dengerates owing to injurious climatic effects or for other reasons, as for instance injurious fermentation, and requires further treatment, such treatment being termed "recuring."

Now this invention has for object by improved treatment or "recuring" to destroy or remove from fruit, deleterious substances, whether resulting from fermentation or the like, or otherwise, and to improve the keeping quality of the fruit as by preventing, arresting or minimizing, fermentation or other injurious effects or for one or more of these purposes.

For the treatment of "double cured" plums, placed or contained in a perforated or other receptacle whereby liquor can obtain free access to the fruit, the plums are, according to this invention, immersed for a short period in a boiling; or practically boiling, solution of weak alkali, then dried by artificial heat and again similarly immersed in boiling, or practically boiling, water that contains in solution small quantities of soda and boracic acid, sulphurous acid or other non-injurious antiseptic after which, the plums, either in a loose or packed condition according to requirement, are again subjected to the action of heat.

In certain cases as for example when the fruit is in fairly good condition it may suffice to immerse it in the boiling or practically boiling solution of soda and antiseptic or possibly of soda alone and subsequently submit it to the action of heat though the complete process as above set forth is usually necessary.

According to one example of the treatment of "double cured plums" according to this invention the fruit contained in a cage or basket is immersed for half a minute or more in a boiling solution of crystalline sodium carbonate in the proportions of about twenty pounds of the said carbonate to one hundred gallons of water, after which the fruit distributed in single layers on trays is subjected in an oven for say thirty minutes or thereabouts to a temperature of from ninety degrees Fahrenheit to one hundred and twenty degrees Fahrenheit, or until sufficiently dry and dark in colour, and then, with or without previous cooling, the fruit, contained in a cage or basket, is immersed for one minute or thereabouts in a boiling solution formed by dissolving about twenty pounds of crystalline sodium car-

bonate and about eight pounds of a solution of commercial sulphurous acid say of 1035 specific gravity in about one hundred gallons of water. The plums after removal from the solution are packed, whilst hot, in boxes and in this state heated for from about thirty minutes to two hours in an oven that is at a temperature of from one hundred degrees Fahrenheit to one hundred and twenty degrees Fahrenheit or thereabouts.

The details of procedure may be more or less varied according to the quality of the particular fruit to be treated. For examples, in fruit of comparatively good condition the proportion of soda in the weak alkali solution may be somewhat reduced with advantage or in some cases a rather weak alkali solution may be caused to answer the purpose by somewhat increasing the period of immersion. Moreover instead of drying the fruit between the above described immersion treatments merely by placing the same in an oven, currents of hot air may be circulated as by fans, amongst and around the fruit.

Sometimes also instead of the final heating being effected whilst the fruit is in boxes or cases in which it has been packed whilst hot, the plums may, in a loose state, be dried by heat and immediately packed hot.

[fol. 1053] For the treatment of "single cured" or sun dried plums the fruit if in good condition may be immersed in the weak alkali solution as in the case of the "cured" plums and then packed whilst hot, and subjected to further heat treatment as described with reference to "double cured plums" after the immersion of such "double cured plums" in the second of the two above mentioned solutions.

In the case of "single cured" plums that are before treatment in comparatively poor condition these may advantageously be treated in all respects as described with reference to "double cured" plums.

Valencias and sultanas are treated according to this invention by subjecting them, after previous treatment by immersion in the weak alkali solution as described in reference to plums or in a weak solution of sodium chloride, to the action of an antiseptic solution or mixture comprising cream of tartar, sodium chloride, water and a covering or protective substance as starch or starchy matter, convenient proportions being say 3 lbs. cream of tartar, 2

lbs sodium chloride, 1 lb starchy matter in the form of arrowroot and 10 gallons of water.

The basket or vessel containing the fruit should be kept in motion during treatment which should be maintained for say half a minute or more, or until any surface sugar crystallization has been removed and internal crystals fused or dissolved after which the fruit arranged in thin layers is subjected in an oven or in any other suitable manner for say two to four hours to a temperature of from say 120° F. to 150° F.

Although various details as to temperatures and periods of treatment and the like have been given by way of examples for fruit treatment according to this invention I desire it to be understood that I do not limit myself thereto but that the same may be more or less varied without departing from this invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I wish it to be understood that I am aware that it has previously been proposed to immerse animal and vegetable substances in a preserving solution of sulphuric acid or other acid or soluble caustic at a temperature of about 60° to 80° F., the substances being subsequently washed and the damp removed therefrom by a current of air or gas, and it has also been proposed in preserving vegetable substances to immerse for about five minutes washed and cut vegetables (carrots, onions, cabbages, cauliflowers, turnips, beans, peas, &c.) in a boiling solution of about one quarter of an ounce of carbonate of soda and two ounces of gum arabic to a gallon of water, the vegetables being afterwards dried, and I declare that what I claim is:

1. In the treatment of dried or partially dried fruit for preservative purposes, subjecting the same to the action of weak hot alkali solution with or without addition of antiseptic material and afterwards to the action of heat.

2. In the treatment of fruit, more particularly dried or partially dried fruit, for preservative purposes, subjecting the same to the action of weak hot alkali solution, drying the fruit, treating it with a weak hot antiseptic solution and afterwards (preferably after packing) subjecting it to the action of heat.

3. In the treatment of fruit according to Claim 2 the employment of a weak solution of non-injurious antiseptic such for example as soda and boracic acid, or sulphurous acid.

4. The method of treating "double cured" plums according to Claim 2 wherein the plums contained in an appropriate receptacle are subjected for half a minute or thereabouts to the action of a boiling solution of about twenty pounds of crystalline sodium carbonate in about one hundred gallons of water, are dried for half an hour or thereabouts at a temperature of from ninety to one hundred and twenty degrees Fahrenheit or thereabouts and are afterwards for one minute or thereabouts subjected [fol. 1054] to the action of a solution of about twenty pounds of crystalline sodium carbonate and about eight pounds of commercial sulphurous acid of about 1035 specific gravity in about one hundred gallons of water, and subsequently for from half an hour to two hours or thereabouts to the action of a temperature of from one hundred to one hundred and twenty degrees Fahrenheit or thereabouts substantially as described and set forth.

5. In the treatment of valencias and sultanas for preservative purposes, subjecting the fruit, after previous alkali treatment, to the action of an antiseptic comprising cream of tartar, sodium chloride and water in appropriate proportions in conjunction with a coating medium as starch or the like and afterwards to heat treatment substantially as described.

6. The methods of treating fruit, particularly dried or partially dried fruit, for preservative purposes substantially as hereinabove described and set forth.

Dated this 13th day of May 1907.

For the Applicant, W. Lloyd Wise, 46 Lincoln's Inn Fields, London, W.C., Chartered Patent Agent.

[fol. 1055] DEFENDANT'S EXHIBIT No. 43

7362.1

The Horticulturist's Rule Book, a Compendium of Useful Information for Fruit Growers, Truck Gardeners, Florists, and Others

By L. H. Bailey

New and Revised Edition

New York: The Macmillan Company. London: Macmillan & Co., Ltd. 1898

All Rights Reserved

[fol. 1056] chloride of lime in a large pitcher, and add same quantity of cold water. Stir well and cover closely to prevent the escape of the chlorine. When the soda-water is cool, pour it on the chloride of lime, stir well together and cover tightly, leaving it for an hour or more. Then pour off very gently the clear liquid, which must be bottled tightly.

This solution will remove fruit-stains from white goods, and will bleach any vegetable substances. When used for cotton or linen, it must be considerably diluted, and the goods well rinsed afterwards.

Waterproof Paper for Artificial Flowers—Waterproof paper, transparent and impervious to grease, is obtained by soaking good paper in an aqueous solution of shellac and borax. It resembles parchment paper in some respects. If the aqueous solution be colored with aniline colors, very handsome paper, of use for artificial flowers, is prepared.

To Keep Flowers Fresh—If cut flowers are not needed immediately, wet them and then wrap them in paper and place in a tight box in a cool place. Keep as cool as possible without freezing.

The disagreeable odor which comes from flowers in vases is due to the decay of the leaves and stems in the water. Therefore remove all the lower leaves befor putting flowers in vases.

Flowers that have stood in a vase for a day or so can be greatly refreshed if taken from the vase at night, thoroughly sprinkled and wrapped, stems, blossoms, and all, as closely as possible in a soaked cloth, and laid aside until the morning. They will be much fresher than if they had been left in their vases, yet will not have bloomed out so much. Before thus laying them aside, and again in the morning, a bit of each stem should be cut off, as the end soon hardens. This ought also to be done once or twice a day, even if the flowers are kept constantly in their vases. Roses which have drooped before their time—as, for example, when worn on the dress—may be revived if the stems, after being thus cut, are placed for ten minutes in al- [fol. 1057] most boiling water and then removed to cold water. It is also well to add a little charcoal or ammonia to the water in which flowers are standing.

If salt is added to the water in which cut flowers are kept, it will delay wilting and decay.

3. Preserving Fruits for Exhibition

1. Corrosive sublimate—which is a violent poison—is prepared at the rate of half an ounce to a gallon of water. Renew the liquid every year or two. Distilled or other very pure water should be used if it is desired to retain the color of the fruit, and glycerine may be added to prevent the fruit from shrinking.

2. Sulphur is sometimes used as follows: Put 30 gallons of water in a 40-gallon barrel; float on top of the water a tin pan, in which put a little sulphur. Set the sulphur on fire and cover the barrel tightly until the fire goes out; renew the sulphur several times, opening the barrel for renewal of air between the doses. The water absorbs the sulphurous acid, and the fluid is then used as a preservative.

Better results are generally obtained if the prepared sulphurous acid is purchased. It costs about 35 cents per pound in 5-pound bottles. Two ounces of the acid is added to a gallon of water.

3. Place an ounce of salicylic acid in 5 gallons water, and then add a little glycerine. The amount of glycerine will depend upon the juiciness of the fruit. The greater

the juiciness, the more glycerine must be added. From 8 to 15 per cent may be considered an average.

Another recipe, and one particularly useful for dark-colored grapes, is as follows: Dissolve an ounce of salicylic acid in 8 ounces of alcohol, and add this to 2 gallons of water. Allow it to stand for a short time before using.

4. Boric acid may be used as a preservative by dissolving a half pound in 50 pounds of water. If the liquid is not clear, filter it. Useful for colored fruits.

5. A solution of zinc chloride, for preserving light-colored and yellow fruits, is made by dissolving 1 pound of the chloride in 50 pounds of water. Filter if the solution is not clear.

[fol. 1058] DEFENDANT'S EXHIBIT No. 44

Daytona Beach, Fla., Sept. 29th, '09.

W. E. Conner, 31 Nassau St. N. Y.

DEAR SIR: I wrote Mr. Chilton the other day to see what arrangement we could make about a cottage, and he answered saying that he wished I would write to you as he thought that you expected to hear from me.

I have looked over your groves at New Smyrna and am very much pleased with the property, but you have something in the "White Fly" that will need close attention.

I would like to work in the grove, am willing to start in any capacity just so there is a chance for advancement if merited, provided we can make arrangements so can have my family there.

Can go down and see Mr. Chilton any day, awaiting yours I remain.

Sincerely, L. D. Niles.

[fol. 1059] DEFENDANTS' EXHIBIT No. 45

E. W. Randall, Director; Samuel B. Green, Horticulture, Forestry; Harry Snyder, Chemistry, Soils; T. L. Haecker, Dairying, Animal Nutrition; M. H. Reynolds, Veterinarian; Andrew Boss, Agriculture, Animal Husbandry; F. L. Washburn, Entomology; E. M. Freeman, Botany, Plant Pathology; Jno. T. Stewart, Farm Eng., Physics; J. A. Hummel, Assistant Chemist; C. C. Lipp, Assistant Veterinarian; C. P. Bull, Assistant in Agriculture; D. A. Gaumnitz, Assistant in Animal Husbandry; A. D. Wilson, Assistant in Agriculture; LeRoy Cady, Assistant in Horticulture; E. G. Cheyney, Assistant in Forestry; L. B. Bassett, Assistant in Agriculture; A. D. Wilhoit, Assistant in Soils; A. G. Ruggles, Assistant in Entomology; Thos. P. Cooper, Assistant in Agriculture; J. A. Vye, Secretary. Address: Telegraph, Minneapolis; Express, Minneapolis; Freight, Minn. Transfer.

University of Minnesota Agricultural Experiment Station,

St. Anthony Park, St. Paul, Minn.

3-24-09.

Hon. Washington Conner, New Smyrna, Fla.

DEAR SIR: What is the chance in your part of Fla. for a poor man (capital about $400.00) age 35 married, two children, strictly temperate, experienced farmer and stockman and able and willing to work.

I am at present in charge of the live stock, at this station, but my contract expires April 15 and I wish to locate in a desirable climate, where I can eventually obtain a small tract of land suitable for intensified farming. Would be pleased to hear of any opening or suggestions you may have to offer.

Sincerely, L. D. Niles.

Reference: Andrew Boss, C. C. Lipp, S. B. Green.

[fol. 1060] Clerk's certificate to foregoing transcript omitted in printing.

[fol. 1061] SUPREME COURT OF THE UNITED STATES

Order Allowing Certiorari. Filed March 17, 1930

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Third Circuit is granted. And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

Endorsed on cover: File No. 34,798. U. S. Circuit Court of Appeals, Third District. Term No. 48. American Fruit Growers, Inc., petitioner, vs. Brogdex Company. Petition for writ of certiorari and exhibit thereto. Filed February 15, 1930. File No. 34,798.